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OPHTHALMOLOGICAL PART.

REPORT AND REMARKS ON A FOURTH AND A FIFTH HUNDRED CATARACT EXTRACTIONS, ACCORDING TO VON GRAEFE'S METHOD.

By H. KNAPP, of New York.

When I published, seven years ago, the report of a third hundred cataract extractions by the peripheric linear section, that method enjoyed an almost uncontested favor on the part of eye surgeons. But as soon as its great originator closed his eyes, a recurrent—not to say reactionary—wave arose in different places. The adherents of the classical flap extraction, held their field, and gained ground. Others made greater or smaller allowances to the flap method, using Graefe's narrow knife, making puncture and counterpuncture in the corneo-scleral juncture, but lower than Von Graefe did, thus forming a flap of small elevation. This variety I saw very extensively practised when I traveled in Europe in 1871. *A. Pagenstecher* continued to extract the lens together with the capsule. *Alfred Graefe* followed the method of his illustrious cousin, but with a lower section. *Adolph Weber* was very sanguine of his method. *Liebreich* performed a more or less linear section, in the lower segment of the cornea, sometimes with, mostly without iridectomy, the centre of the section lying about midway between the centre of the cornea and its lower margin. *Le Brun* did

the same in the upper segment. Two years ago, *L. de Wecker* published his "new method of cataract extraction—extraction with a peripheric flap—" (Paris, Gauthier-Villars, 1875, see these Arch. IV. p. 465), and his assistant, Masselon, communicated the results of 179 operations done according to this method. (See these Archives, vol. V. p. 239). *Wecker's* peripheric flap is situated in the limbus conjunctivæ, and comprises one-third of the circumference of the limbus. No iridectomy is performed. Prolapsed iris is pushed back with a blunt spatula, and kept in position by the instillation of the alcaloid of calabar bean, called eserine.

Besides these, there are many unimportant deviations from Graefe's method which I need not mention.

Does the method of a great practical genius deserve to be so soon abandoned, or is this recurrent movement only the natural reaction after too enthusiastic expectations? The discussion of this question can be taken up by theoretical reasoning, or by statistical deductions, or by both combinedly. The latter is the best way. In this sense I shall endeavor to analyze the last two hundred cases of extraction, which I have made according to V. Graefe's method. I shall begin with the statistical part, and thus deduct from facts the influence, favorable or prejudicial, which each factor of our problem exercises on the immediate and final results. In order to make the deductions as objective as possible, and divest them from my personal views, I shall present condensed histories of the cases in a tabulated form, extracted from the extensive records kept by the resident assistant surgeons of the N. Y. Ophthalmic and Aural Institute. The cases are not, in any way, selected; but represent all that I have operated on according to Graefe's method, from April, 1869, to June, 1876, with the exception of a few cases in which detachment of the retina was present and diagnosticated before the operation. Detachment of the retina is commonly considered a contra-indication to any operation for cataract. Yet, if there is only one eye left, and this suffers from cataract and absence of the upper half of the field of vision, the operation, it seems to me, is justifiable, and in some cases on which I have operated,

the patients were so much benefited that for some years they were enabled to see their way in walking. The 200 cases of extraction here compiled are not the only ones which I performed in the space of seven years. Several times I abandoned Graefe's method and tried another. This was, however, not done in such a way that the promising cases were given to the new method, and the unpromising to Graefe's, but when I determined to test the value of a new method, I tried it on all cases that came under my care. Though the results I obtained by *Graefe's* method in America fall short of what I obtained by it in Heidelberg, I still adhere to it as the method which yielded me better results than any other I have tried.

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
1	J. M. Heb. N. Y. City.	70	Decrepit and nervous man.	Hard. Ripe.		April, 1869.	Peripheric section.	No anæsthesia. Escape of *vitreous* by spasmodic closure of lids during pressure on cornea. Lens extracted with large *spoon* easily and totally.
2	G. M. Ger. Egg H'rbor N. Y.	66		Hard. Ripe.		June, 1869.		
3	D. B. Ger. Poughkeepsie, N. Y.	60		Hard. Ripe.		May, 1869.		Cortex and blood remained in anterior chamber.
4	Mrs. H. Cr. Am. Hebron, N. Y.	54		Hypermature		June, 1869.	Cut rather small.	Expulsion difficult.
5	F. H. Ger. Union Sp'ngs Ala.	50		Hypermature		Sept. 1869.	Anterior capsule removed with cystotome.	

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS				
Very painful *hyalitis*, cyclitis and iritis, with closure of pupil. From the fifth to the tenth day + T1. After six weeks eye quiet. T1. Treatment internal: sedative; local: atropine and leeches.	35	$\frac{1}{\infty}$		$\frac{1}{\infty}$	The loss of the eye was caused by the introduction of a large spoon. *Anæsthesia* might have obviated the loss of vitreous, and saved the eye. Patient died 18 months after operation of general debility.
	24	$\frac{20}{50}$		$\frac{20}{20}$	
Hurt eye eleven days after operation. Wound *reopened*, but closed again in two days. Discharged with considerable *cortex* in anterior chamber. Free from irritation.	19	$\frac{10}{200}$		$\frac{20}{40}$	
	10	$\frac{20}{100}$		$\frac{20}{50}$	
Wound spontaneously (?) reopened on 3d day, but closed the following night.	14	$\frac{20}{70}$			

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
6	Mrs. M. Am. B'klyn	60		Hard.				Section *small.* Considerable *rubbing* to expel the remnants of tenacious corticalis.
7	A. M. Heb. N. Y. City.	58	Nervous, timid man.	Hard.	Externally nothing unusual. Highly myopic.	Oct. 1869.		Blood after section, quickly coagulating, made other steps of operation difficult. No accident. Chloroform.
8	Mrs. T. St. Heb. N. Y. City.	63		Hard.				
9	Mrs. M. C. Irish. N. Y. City.	62		Hard. Ripe.		Nov. 1869.	Usual Graefe's section: apex touching corneal margin.	
10	Dr. W. Am. N. Ca.	67		Hard.	Eye deep-seated.	Nov. 1869.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
Ring-abscess. Panophthalmitis. Phthisis bulbi.	DAYS 17	0		0	The loss is attributed to the bruising of the small wound during extrusion of lens and cortex.
	16	$\frac{6}{200}$		$\frac{20}{100}$	Extensive sclero-choroiditis and rarefaction of choroid. Other eye had unsuccessfully been operated on two years previously.
	12	$\frac{20}{100}$		$\frac{20}{50}$	Died two years later.
Suppuration began at inner corner of wound in cornea and iris. Unsuccessfully treated by warm applications and paracentesis of ant. chamber by reopening the wound. Flat leucoma.	14	0		0	
	18	$\frac{15}{200}$	The center of a thin secondary cataract torn with a sickle needle 20 days after	$\frac{15}{200}$	The optical conditions being excellent, atrophy of opt. disc was discovered ophthalmoscopically as

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
10								
11 12	Mrs. B. S. Ger. Newark, N. J.	58		Hard. Ripe, in both eyes.		Dec. 1869.	Both eyes at the same time.	
13	A. F. S. Ger. N. Y. City	61		Hard. Ripe.				
14	Mrs. Z. Ger. Ct.	42		Immature. Swollen.		Feb. 1870.		Capsule opened with knife during its passage through anterior chamber.
15	Mrs. I. Am. Newark, N. J.	76		Complicated.	High degree of M. Synechiæ. Post. capsule thickened.	March 1870.	Sec. down & outward. Iridectomy removing all synechiæ. Thickened caps. circumcis'd with cystotome, and ext. with forceps.	

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS		extract. Reaction slight. Pupil clear. Discharged 5 days after secondary operation.		the cause of low V.—— Other eye unsucessfully operated on (by extraction) previously. Died a year after operation.
	16	$\frac{20}{100}$		$\frac{20}{50}$	
		$\frac{20}{100}$		$\frac{20}{50}$	
On third day hemorrhage in ant. chamber from patient hurting his eye during bandaging. Disappeared in a few days.	12	$\frac{20}{50}$		$\frac{20}{20}$	
Cystoid protrusion in one corner of wound. No irritation from it up to this time, May, 1877.	11	$\frac{20}{200}$	Division of sec. cataract with sickle needle 6 mos. after extraction. No reaction.	$\frac{20}{40}$	The other eye being unaffected, the extraction should have been delayed until the swelling by imbibition of the cataract had disappeared.
	9	$\frac{20}{200}$		$\frac{20}{50}$	

No. of Case.	*Name. Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
16 17	L. S. Ger. Brook-lyn, N. Y.	57		Right eye hard, left eye hyper-mature with thick-ened cap-sule.		May, 1870.		Left: Dislocation of lens while tearing the capsule. Thickened capsule extracted. On pressure with spoon, vitreous pres'nted. Lens extracted with large spoon. One or two drops of vitreous escaped.
18	F. Pf. Ger. N. Y. City.	61		Hard. Ripe.		May, 1870.		
19	M. R. Ger. N. Y. City.	64		Hard. Ripe.		June, 1870.		Dislocation of lens with cystotome. Lens extracted with sharp hook. A few drops of vitreous escaped.
20	C. B. Ger. N. Y. City.	37		Soft. Ripe.	7 months previously a small piece of iron pierced the cornea & remained in the ant. cortex,	May, 1870.	Piece of iron came out with lens.	

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 16	$\frac{20}{100}$			
Left tardy union of wound.		$\frac{20}{100}$			
	13	$\frac{20}{100}$			
	8	$\frac{20}{100}$			
The third day *spongy exudation* appeared in ant. chamber, fourth day densest, filling the whole chamber. Pulse 72. Chemosis, 5th day: it began to absorb from the periphery, showing sharp edges.	12	$\frac{20}{100}$		$\frac{20}{30}$	

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
20					where it was seen during the extraction and removed with the lens.			
21	S. L. Span. Porto Rico.	46		Hard. Ripe.		July, 1870.	Usual peripheric linear section.	A small quantity of cortical substance left.
22	S. K. Ger. N. Y.	58		Hard. Ripe.	Coloboma from previous iridectomy.	Aug. 1870.	Large section for large lens.	
23	G. S. Ger. Newark, N. J.	59		Hard. Ripe.		Sept. 1870.		
24	B. K. Ger. Blissville, L. I.	50		Hard. Ripe.		Sept. 1870.	Center of anterior capsule removed.	
25	J.A.D. Fren. N. Y. City.	36		Half-soft. Large.				Capsule divided with knife in passing through ant. chamber.

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS				
6th day, no chemosis. Exudation limited to pupillary space. Iris clear. 10th day: pupil free and clear, iris bright.	12	$\frac{20}{100}$		$\frac{20}{30}$	
The 2d day purulent infiltration of the wound under the conjunctival flap. Pain. Chemosis. Pulse, 60. 3d day ant. chamber filled with dark blood. Slow iritis. Closure of pupil.	26	$\frac{1}{\infty}$ in all p'rts of F.			The weather was very hot. He said that in Porto Rico, his home, he had not suffered so much from the heat as in New York.
No reaction whatever.	7	$\frac{20}{100}$		$\frac{20}{30}$	
Capsulitis plastica. Blood in pupil. Pupil large.	12	$\frac{10}{200}$			Patient left the hospital without permission. Prospect of improvement of S. favorable.
	11	$\frac{20}{40}$		$\frac{20}{20}$	
	12	$\frac{20}{50}$			

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Exsecution of Operation.*	*Incidents of Operation.*
26	M. S. Ger. N. Y. City.	67		Hard. Ripe.	Corneal specks.	Oct. 1870.		
27	H. W. Ger. N. Y. City.	43		Half-soft.		Oct. 1870.		
28	Mrs. E. W. Ger. N. Y. City.	63		Hard.		Oct. 1870.		Escape of some vitreous, when spoon pressed upon cornea. Lens expelled by cautious pressure, no instrument entering the eye.
29	Miss J. L. Am. N. Y. City.	36		Hyper mature flat, disciform. Centre of capsule thickened.		Oct. 1870.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operation.*	*Ultimate V.*	*REMARKS.*
	DAYS 11	$\frac{20}{200}$			
Pupil clouded.	14	$\frac{15}{200}$	Division of pupillary membrane 9 days after extraction. No reaction. Discharged 5 days later.	$\frac{20}{70}$	
	17			$\frac{20}{50}$	
Pupillary opacities.	8	$\frac{13}{200}$	Division 5 weeks after extraction. No reaction.	$\frac{20}{30}$	Extraction in the other eye 7 years previously had been followed by pupillary opacities They were divided at the same time with the eye before mentioned. Severe reaction followed for six weeks. No improvement.

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
30	M. L. Am. N. Y. City.	31		Soft. Ripe.		Oct. 1870.	Centre of capsule removed.	
31	Rev. D. Am. Belleville, N. Y.	72		Hard. Ripe.				
32	Mrs. C. B. Am. Morrisania, N. Y.	45		Half-soft.		Oct. 1870.	A good deal of *rubbing* on cornea in removing the corticalis.	
33	A. McS. Irish. N. Y. City.	61		Hard. Ripe.		Oct. 1870.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 6	$\frac{20}{70}$		$\frac{20}{20}$	
On fourth day, blood in anterior chamber, absorbed in six days.	11	$\frac{20}{50}$	Six months after extract. S. $\frac{20}{100}$. Division of wrinkled caps. with Graefe's knife. No reaction. Discharged in 5 days.	$\frac{20}{40}$	
On 3d day pain. Lids and conjunctiva swollen. Centre of wound bulging and white. Ant. chamber turbid. Iris swollen. Pupil narrow. The bulging portion of wound *incised*, perpendicularly to section, pus removed. Leeches to temple. Atropine. The inflammation (*keratitis suppurativa partialis et iritis*) at once abated, and ended in 10 days.	12	$\frac{20}{200}$		$\frac{20}{70}$	
The *second day* œdema of lids. Pulse 84. Chemosis. Iris discolored. Inner angle of wound white, raised. It was incised and pus liberated. Symptoms abated. *3d day:* Purulent secretion. Inner angle healthy looking. Outer angle of wound white. swollen; puriform exuda-	21	$\frac{6}{200}$	63 days after extraction iridectomy, connecting with pupil. Incision with Beers' knife through pupillary membrane. Iris drawn out with Tyrell's hook.	$\frac{20}{40}$	The splendid recovery in this case is attributed to the energetic after-treatment.

No. of Case.	Name. Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
33		61				Oct. 1870.		
34	A. L. Ger. N. Y. City.	50		Very old traumatic and partially dislocated cataract which had freed him from military service. Anterior capsule thickened. (Complicat'd)		Nov. 1870.		Immediately after the section fluid vitreous escaped. The prolapsed iris was cut off. Lens was brought out with capsule by spoon passed behind post. capsule. During extraction a hard rubber spoon was gently pressed on the cornea, following the course of the lens from below upward. Loss of vitreous inconsiderable. Wound closed nicely.

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
tion extending from it into ant. chamber. Ant. chamber cloudy; iris swollen, yellowish white. Pupil plugged with a grayish-white substance. Outer angle deeply incised, pus liberated; six leeches to temple. *4th day:* Less pain at night. Purulent discharge diminished. Edges of wound in their whole length white, infiltrated. Ant. chamber filled with whitish flakes. Pulse 75. Wound vertically incised at several points, anterior chamber tapped, and almost all the pus in it evacuated. *5th day:* No pain during night. Discharge less; anterior chamber restored, clear. Pupil partially free. The inflammatory symptoms steadily abated. Pupillary membrane. Tn. F complete.	DAYS				
2d day: ant. chamb. filled, middle third of wound gaping, but bridged over by raised conjunctiva. The conjunctiva was incised several times, but it always closed again over night, and the union of the wound progressed but slowly from the sides. From the 13th to the 28th day the gaping wound was touched five times with nitrate of silver in substance, which reduced its size to about one-fourth. Pat. wanted to leave the Hospital. At his house I touched the wound twice at an interval of seven days. The first touching was followed by hardly any reaction, the second by suppurative inflammation, which destroyed the eye.	28	$\frac{20}{70}$		0	It is likely that without the touching the wound would slowly have closed, and the eye might have recovered.

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
35	Mrs. S. G. Am. N. Y. City.	65		Hyper-mature; thickened capsule.		Nov. 1870.	Anterior capsule removed.	The section, too small for the lens, was extended, after which the cataract readily slipped out. (Smooth.)
36	Mrs. A. F. Ger. N. Y. City.	57		Hard. Ripe.				
37	Mrs. C. Am. Hebron, N. Y.	50		Ripe. Hard.		Nov. 1870.	A very smooth operation. Pat. told time at the watch to the minute.	
38	J.U.F. Ger. N. Y. City.	45		Half-soft. Ripe.		Nov. 1871.		
39 40	J. G. Neg. N. Y. City.	71	Fat & feeble.	Both hyper-mature		Dec. 1871.		
41	J. G. Irish. N. Y. City.	61		Ripe. Hard.		Dec. 1871.		
42	J.W. K Ger. Vancouvers I.	61		Partially dislocated; capsule thicken-		Jan. 1872.		The thickened portion of capsule was circumcised; but could not be removed

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
After-bleeding in ant. chamb. four days after extraction. In the course of 18 months V diminished to $\frac{15}{200}$ by vertically folded and striped secondary cataract (posterior capsule).	DAYS 10	$\frac{20}{70}$	18 months after operation division of sec. cataract by Graefe's knife. Reaction slight.	$\frac{20}{70}$	Three years after the second operation plastic cyclitis and opacities of the vitreous set in, reducing V to $\frac{1}{200}$. No irritation of other eye.
	13	$\frac{20}{50}$ $\frac{20}{20}$	(4 months.) (5 years.)		
Suppuration, beginning at the edges of the wound, presenting the form of ring abscess the third day. Panophthalmitis.	18	0		0	The other eye successfully operated on 15 months previously. Case 4 of this table.
	9	$\frac{10}{50}$		$\frac{20}{30}$	
Slow healing. Wounds gaping and ectatic. Cystoid cicatrices, synechiæ and pupillary obstructions in both.	25	$\frac{6}{200}$ $\frac{15}{200}$			
Swelling of lids and conjunctiva. Copious muco-serous discharge. Spongy exudation. Iritis. Slight synechiæ.	18	$\frac{20}{100}$		$\frac{20}{50}$	
On the 7th day, struck his eye, the recovery of which had proceeded favorably.	14	$\frac{20}{100}$		$\frac{20}{70}$	

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
42		61		ed (complicated.)		Jan. 1872.		with forceps. After the expulsion of the lens, it was extracted with forceps. Some cortex remaining.
43	M. R. Ger. N. Y. City.	48		Half-soft, mature		Jan. 1872.	Knife split the capsules, but a more extensive laceration was made afterwards.	
44	F. O. Ger. N. Y. City.	69		Hard. Ripe.		Feb. 1872.	A quadrangular piece of anterior capsule removed.	
45	Mrs. M. K. Ger. N. Y. City.	59		Hard. Ripe.		Feb. 1872.	Quadrangular piece of capsule cut out.	

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
The wound burst and some vitreous escaped. No bad consequences.	DAYS				
	12	$\frac{20}{70}$			
Capsulitis Suppurativa et hæmorrhagica.—The upper edge of the remaining capsule first showed white patches, then became uniformly white, thickened and pervaded with blood-vessels. While the upper portion was clearing up, the inner, then the lower, and at last the outer edge of the quadrangular opening in the capsule became successively white and thickened. Hypopyon and repeated abundant hemorrhages took place. When he left, the exudation in the pupil was diminished, the shape and tension of the globe being normal.	34	$\frac{1}{\infty}$ F. complete.			
	8	$\frac{20}{70}$		$\frac{20}{30}$	

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
46	Mrs. B. M. Ger. Newark, N. J.	55		Hard. Ripe.		March 1872.	Capsule cut out.	
47	C. S. Am. Or'nge N. J.	42		Hard. Ripe.		Mar., 1872.	Capsule cut out.	
48	S. L. Heb. N. Y. City	60	.	Hypermature		Feb. 1872.		
49	C. Bl. Ger. Adrian Mich.	56		Nuclear cataract. Cortex still semi-transparent in both eyes. (Immature.)		April, 1872.	Knife was blunt requiring a good deal of dragging and sawing.	After division of ant. capsule vitreous exuded without any pressure on the eye. Cataracts easily extracted with large spoon, a small quantity of vitreous followed. Wound closed well.
50	Mrs. M. M. Irish, Hoboken, N. J.	41		Disciform, old, (hyp'r-mature.)		April, 1872.		Great pressure had to be employed to expel the lens, upon which a small quantity of vitreous escaped.

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 14	$\frac{20}{100}$		$\frac{20}{40}$	
	14	$\frac{20}{100}$ Two m'ths later. $\frac{20}{20}$	Six months later V reduced by vertically striated secondary cataract. Division with Graefe's knife, a year after extraction resulted in	V. $\frac{20}{20}$ permanent.	
	11	$\frac{20}{100}$		$\frac{20}{30}$	
Cyclitis.—4th day, yellowish reflex from well dilated pupil. *10th day:* synechiæ and pupillary membrane. 16: Hemorrhage in ant. cham. 19: more hemorrhage: iris bulging forward. 39th: Eye shrunken. Iris bulging. Perception of light faint, pain, which had been acute, disappeared.	39	$\frac{1}{\infty}$		0	
	11	$\frac{20}{70}$		$\frac{20}{30}$	

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
51	M. L. Am. N. Y. City.	32		Soft.		April, 1872.		
52	C. B. Am. Strat-ford.	76		Hard. Ripe.		April, 1872.		
53	Mrs. F. M. Am. B'klyn N. Y.	58	·	Hard.	Inner lower quadrant of F. absent; nothing to account for it.	May, 1872.		Some blood and cortical substance left.
54 55	Mrs. U Am. N. Y. City.	78	Decrepit and childish.	Hard. Ripe. Both.		May, 1872.		Left eye: inner border of iris pushed out of wound by passing lens.
56	Mrs. C. A. Am. N. Y. City.	54		Hyper-mature		May, 1872.		
57	K. V. Ger. Jersey City, N. J.	42		Hard.		May, 1872.		
58	Mrs. M. W. Irish, N. Y. City.	56		Hard. Ripe.		May, 1872.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 6	$\frac{20}{200}$		$\frac{20}{30}$	
	11	$\frac{20}{200}$		$\frac{20}{30}$	Other eye unsuccessfully operated on 4 years previously.
From the fifth to the twelfth day conjunctiva injected and swollen. Opacity in centre and upper part of cornea, deepseated as if produced by scraping with the cystotome.	26	$\frac{20}{200}$		$\frac{20}{70}$	
L. Violent iritis: plug in pupil, hypopyon. After absorption dense pupillary opacity.	21	$\frac{20}{100}$ $\frac{1}{\infty}$		$\frac{20}{50}$ $\frac{5}{200}$	
	13	$\frac{20}{50}$		$\frac{20}{30}$	
	15	$\frac{20}{100}$		$\frac{20}{50}$	
Iritis. Dense pupillary membrane.	21	$\frac{10}{200}$	Iridectomy downward, not very successful: pseudo-membrane extending downward also. Division of membrane at first of	$\frac{10}{200}$ $\frac{20}{100}$ Permanent. (May 1876)	Other eye had been operated on before. Closure of pupil. V. $\frac{20}{100}$ by artificial pupil.

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
58		56				May, 1872.		
59	J. W. Ger. New-ark, N. J.	62		Hard. Ripe.		June, 1872.		
60	T. G. Ger. N. Y. City.	72		Hard. Ripe.		June, 1872.		
61	J. D. Am. N. Y.	60		Hard. Ripe.	Left eye. Chronic Iritis.	June, 1872.		
62	S. M. Am. N. Y. City.	50		Hard. Ripe.		June, 1872.		
63	Mr. M. D. Ger. N. Y. City.	65		Hard. Ripe.		June, 1872.		Some vitreous escaped.
64	J. Ch. Heb. N. Y. City.	78		Hard. Ripe.		Oct. 1872.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS		little benefit; improvement later. Floating opacities in vitreous.		
Iritis; pupillary membrane. Prospects by after-operation very favorable.	16	$\frac{10}{200}$			Other eye operated on previously: phthisis bulbi.
Iritis. Pupillary membrane.	29	$\frac{2}{100}$	Discission with Beer's knife. Pupil perfectly clear.	$\frac{20}{70}$	
Iritis and keratitis suppurativa in both corners of wound. These corners incised. Pupillary membrane.	26	$\frac{1}{200}$	Division with Beer's knife 18 months later.	$\frac{20}{100}$	Had a good deal of irritation in both eyes, for months after his discharge. Left iridocyclitis absolute.
	11	$\frac{20}{100}$		$\frac{20}{20}$	
Iritis. Pupillary membrane. Iris drawn upward toward wound.	21	$\frac{5}{200}$	4 months after extr. triangular *iridotomy* with scissors, followed by panophthalmitis.	0	
	16	$\frac{20}{200}$		$\frac{20}{100}$	

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
65	J. K. Am. N. Y. City.	56		Hard. Ripe.		Oct. 1872.		
66	Mrs. V. Fr. N. Y. City.	70		Hy-perma-ture.	Old poste-rior syne-chiæ.	Oct. 1872.		
67	Mrs. B. Am. Buff'lo, N. Y.	77		Hy-perma-ture.		Oct. 1872.		
68	N. K. Ger. N. Y.	49		Hard. Ripe.		Oct. 1872.		
69	Mrs. C. Am. Sussex Co. N. Y.	49		Hard. Ripe.		Oct. 1872.	Capsule removed.	
70	A. W. Ger. Hobo-ken, N. J.	28		Soft. Ripe.		Nov. 1872.		
71	Mrs. M. D. Irish, Hobo-ken, N. J.	40		Half-soft.		Nov. 1872.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 9	$\frac{20}{40}$		$\frac{20}{30}$	
	13			$\frac{20}{70}$	
	11	$\frac{20}{200}$		$\frac{20}{100}$	
	11	$\frac{20}{70}$		$\frac{20}{30}$	
Plastic capsulitis, beginning at upper border of capsule which became white and thickened. The inflammation travelled around, produced some synechiæ, but left centre of pupil free.	17	$\frac{20}{200}$		$\frac{20}{70}$ six we'ks $\frac{20}{20}$ (four years later.)	
	10	$\frac{20}{100}$		$\frac{20}{20}$	
	18	$\frac{20}{70}$		$\frac{20}{20}$	

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
72	A. L. Heb. Mont-gom'ry Ala.	55		Hard. Ripe.		Nov. 1872.		
73 74	L. C. Am. N. Y. City.	44		Hard. Ripe, (both).		Nov. 1872.		
75	Dr. D. Ger. N. Y. City.	62		Hard. Ripe.		Dec. 1872.		
76	C. M. Am. N. Y. City.	69		Hard. Ripe.				
77	J. S. Ger. N. Y. City.	72		Hard. Ripe.		Jan. 1873.		
78	Mrs. C. D. Irish. N. Y. City.	63		Hard. Ripe.		Feb. 1873.		
79	H. K. Am. N. Y. City.	59		Hard. Ripe.		April, 1873.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 16	$\frac{20}{40}$		$\frac{20}{20}$	
R. eye. Spongy exudation, taking a favorable course. Some capsular opacities. *L. eye.* Plastic iritis. Closure of pupil.	13	$\frac{20}{200}$ $\frac{1}{8}$ F, c. Tn.		$\frac{20}{100}$	Returned 3 weeks after his discharge, having a relaspe of capsulitis with hypopyon in his right eye. Under antiphlogistic treatment recovered slowly. V $\frac{20}{200}$, and 2 months later V $\frac{20}{100}$.
.	9	$\frac{20}{50}$		$\frac{20}{20}$	
	14	$\frac{20}{20}$		$\frac{20}{40}$	
	13	$\frac{20}{100}$		$\frac{20}{40}$	
	11	$\frac{20}{100}$		$\frac{20}{30}$	
	12	$\frac{20}{70}$		$\frac{20}{50}$	

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
80	J. H. Ger. N. Y. City.	59		Hard. Ripe.		April, 1873.		
81	M. C. Irish. N. Y. City.	62		Hard. Ripe.		May, 1873.		
82	Mrs. F. Am. B'dgeport, Ct.	80		Hypermature.		May, 1873.		Inner border of iris pushed into the wound and bruised by passing lens.
83	F. M. Ger. Carlstadt, N. J.	65		Morgagnian Hypermature.		May, 1873.		
84	Mrs. L. R. Am. N. Y. City.	57		Complicated.	Leucoma adhærens corneæ centrale.	May, 1873.		
85	S. S. Heb. N. Y. City.	43		Zonular congenit (Immature.)		May, 1873.		Pupil appeared clear, but showed cortical substance and a strip of capsule the next day.
86	D. C. G. Am. B'klyn N. Y.	61		Hard. Ripe.	Centre of anterior capsule thickened.	May, 1873.	Centre of ant. caps. circumcised came out with cataract.	

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
Purulent Iritis. Panophthalmitis.	DAYS 14	0		0	
	12	$\frac{20}{200}$		$\frac{20}{40}$	
Purulent iritis, starting from inner border of coloboma. Panophthalmitis.	21	0		0	Other eye had been unsuccessfully operated on four years previously.
	18	$\frac{20}{100}$		$\frac{20}{40}$	
Iritis. Pupillary membrane.	11	$\frac{15}{200}$	Division four weeks after extraction. No reaction.	$\frac{20}{50}$	
Recurrent capsulitis and irido-cyclitis, leaving dense secondary cataract.	60	$\frac{1}{200}$	Iridectomy.	$\frac{2}{200}$	Eye remained irritable (irido-cyclitis) for two years, but never affected the other.
	12	$\frac{20}{70}$		$\frac{20}{30}$	

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
87	Mrs. E. K. Am. Hoboken, N. J.	79	Excessively decrepit Skin like paper.	Hypermature.		May. 1873.	Section strictly peripheric.	
88	G. O. Ger. Savannah, Ga.	60		Hard. Ripe.		June, 1873.		
89	H. H. Am. Atlanta, Ga.	58		Hypermature.		June, 1873.		
90	M. B. Ger. Philadelphia, Pa.	72		Hypermature.		June, 1873.		
91	V. W. Am. N. Y. City.	72		Morgagnian. Hypermature cum bursa.		June, 1873.		After the soft cortical substance and the hard nucleus had come out, a white bag showed itself in the pupillary space. It was pressed out with some effort by means of two spoons, a silver spoon keeping the lips of the wound apart, and a rubber spoon pressing on the

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
2d day: Wound open and slightly gaping. *3d day:* Suppuration in corners of wound. Panophthalmitis.	DAYS 14	0		0	
	18	$\frac{20}{100}$		$\frac{20}{40}$	
	14	$\frac{20}{70}$		$\frac{20}{30}$	
	20	$\frac{20}{200}$		$\frac{20}{50}$	
	12	$\frac{20}{100}$		$\frac{20}{70}$	

No. of Case.	*Name. Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
91		72				June, 1873.		cornea and pushing the bag toward the section. The bag, apparently a recess of the capsule, burst, a milky fluid escaped, and the wrinkled bag remained at the upper border of the coloboma, leaving the centre of the pupil perfectly free (no accident)
92	Mrs. B. A. Ger. Rye, N. Y.	52		Hard. Ripe.		June, 1873.		
93 94	Mrs. B. F. Irish. N. Y. City.	60		R. Hypermature. L. Hard. Ripe.		June, 1873.		
95	Mrs. M. K. Ger. N. Y. City.	60		Hard. Ripe.		June, 1873.		
96	J. B. Am. B'klyn N. Y.	60		Hard. Ripe.		June, 1873.		

Course of Healing Process and After-Treatment.	Length of Treatment.	V. at time of Discharge.	After-Operations	Ultimate V.	REMARKS.
	DAYS 12	$\frac{20}{100}$		$\frac{20}{70}$	
	13	$\frac{20}{70}$		$\frac{20}{40}$	
Incarcerated iris in both eyes; causing no annoyance.	11	$\frac{20}{70}$ $\frac{20}{70}$	Jan. 1877 S. sunken to $\frac{10}{200}$ from pupillary membranes. Division by needle gave in 9 days	$\frac{20}{50}$ $\frac{20}{40}$	The prolapse of iris in right eye became red on 4th day, was excised. Recovery perfect.
	9	$\frac{20}{100}$		$\frac{20}{30}$	
	5	$\frac{20}{100}$		$\frac{20}{20}$	

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
97	M. Span. N. Y. City.	37		Half-soft. Ripe.		July, 1873.		
98	C.P.S. Am. Springfield, Mass.	41	Excellent.	Ripe.		Sept. 1873.	Apex of section 1 mm. in cornea.	
99	A. B. Heb. Chicago, Ill.	69	Plethorical. Excitable.	Hard. Ripe.	Pupil moderately dilated by atropine. Eye myopic.	Sept. 1873.	Ap. of sect. touching transparent cornea. Wound enlarged with scissors.	A small quantity of cortex left.
100	L. N. Am. N. Y. City.	55	Feeble.	Immature. Swollen.		Sept. 1873.		Some lens and tough capsule remained in the pupil.
101	B. E. Ger. Maine.	54	Good.	Half-soft. Ripe.	Arc. senilis pronounced.	Oct. 1873.	Remnants of corticalis removed by considerable rubbing. Conjunctival flap.	A small piece of iris, caught in the inner corner of the wound, was cut off. (Accident.)

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 12			$\frac{20}{40}$	
	14	$\frac{20}{30}$		$\frac{20}{20}$	
Some irritation at corners of section where iris was adherent.	20	$\frac{20}{70}$	9 weeks after extraction division of sec. cataract with needle. No reaction.	$\frac{20}{40}$	A year later had hemorrhage into the vitreous, which left floating bodies and, at the time of discharge, V $\frac{20}{70}$.
Marked *spongy exudation.* Absorption on the fifth day. The gelatinous exudation looked like a dislocated lens, with a sharp somewhat ragged edge. Pupillary membrane.	20	$\frac{10}{100}$	6 weeks after extraction a crucial division of the pupillary membrane, producing a very clear pupil, and no reaction.	$\frac{20}{70}$ S'v'n we'ks aft er ex tr. Six d a ys aft e r d i vi-sion.	
Pain and mucous secretion. Conjunctiva raised. Inner corner of section whitish. From it white exudation (pus) descending tongue-like into ant. chamb. Iris discolored ; aqueous turbid. This condition lasted a week, during	35	$\frac{12}{200}$	30 days after the extraction, when the irritation had almost disappeared, but a tendency to closure of the pupil and stretching of the iris was still manifest, a Beer's knife was thrust through	$\frac{20}{70}$ Thr'e we'ks aft e r sec'n-d a ry oper-ation.	

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
101		54				Oct. 1873.		
102	N. H. Ger. Newark, N. J.	57	Good.	Hard. Ripe (nine years).	Myopic.	Oct. 1873.	Apex of sec. 1 mm. below margin of cornea.	
103	N. B. Am. Detroit, Mich.	54		Hypermature. Cholesterinic and chalky deposits.		Oct. 1873.	Apex of sec. 1 mm. below mar. Section large.	Tough capsule torn, but lens would not move on pressure. Extracted with *large spoon.* Thickened capsule removed with forceps.

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
which time the wound was incised and the anterior chamber emptied every day. Then the inflammation gradually disappeared, leaving a dense pupillary membrane.	DAYS		the lower part of the cornea and upper part of the iris. The lower lip of the *iridotomy* wound was seized with a blunt hook, and drawn toward the wound, in order to be cut off, but it slipped off the hook. As a large opening appeared in the iris, through which vitreous passed into the ant. chamb., and even out of the corneal wound, no further attempt at iridectomy was made. Little reaction followed and patient was discharged six days later with a clear pupil.		
	14	$\frac{20}{200}$		$\frac{20}{70}$	
No reaction until the fifth day; then circumcorneal injection, hyperæmia of iris, haziness of pupil and vitreous. Eye tender. Irritation (*hyalitis*) gradually subsided.	40	$\frac{20}{100}$			

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
104	Mrs. C. Am. N. Y. City.	78	Good.	Hard. Ripe.	Large arc. senilis.	Oct. 1873.		
105	Mrs. C. B. Ger. N. Y. City.	38	Phthisis pulmon.	Soft. Ripe.		Nov. 1873.		
106	J. W. H. Am. Boston, Mass.	39		Ripe.		Nov. 1873.		
107	L. R. Am. Syracuse, N. Y.	55		Ripe.			Quadrangular piece of capsule excised.	
108	J. W. Ger. Syracuse, N. Y.	66		Hypermature.	Myopic.	Nov. 1873.	Apex of sec. 1 mm. below corneal margin.	In cutting the iris, a small piece of the ant. lip of the section was cut.
109	Dr. J. M. Am. Oberlin, Ohio.	71		Hypermature.	Myopic.	Dec. 1873.	Capsule resisted Weber's double hook, therefore	Cataract extracted together with capsule by large spoon. Escape of vitreous.

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 14	$\frac{20}{70}$		$\frac{20}{40}$, $2\frac{1}{2}$ y's later.	
On fourth day, *spongy exudation*, lasting five days. Portion of anterior capsule in pupil. Remainder of pupil clear.	13	$\frac{20}{200}$			
	17	$\frac{20}{70}$		$\frac{20}{20}$	
	15	$\frac{20}{50}$			
Slow closure of wound. Chemosis. Circumscribed purulent infiltration of wound; irritation gradually disappearing, leaving interior clear, but a part of the pupil filled with capsule.	36	$\frac{20}{70}$			
Recovery, without notable irritation.	21	$\frac{20}{70}$		$\frac{20}{70}$ 3 m'ths	

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
110	N. A. P. Am. N. Y. City.	65		Hard. Ripe		Jan. 1874.	Apex of sec. $1\frac{1}{2}$ mm. below margin.	
111	Dr. Br. Ger. B'klyn	73	Decrepit. Cough. Prostatitis.	Hard. Ripe.	Pupil dilated but little by atropia.	Jan. 1874.	Apex of sec. 2 mm. below margin.	
112	J. M. Irish, N. Y City.	49		Cataracta accret.	Leucoma adhærens from burns. Iridectomy had been made.	Jan. 1874.	Section inward.	
113	G. K. Ger. N. Y. City.	61	Asthma.	Ripe.		Feb., 1874.		
114	G. B. Irish, N. Y. City.	52		Cataracta accreta.	Kerato-iritis, with closure of pupil 5 yrs. previously. Iridectomy $1\frac{1}{2}$ years previously. Trachoma and pannus one year.	Feb., 1874.	Section inward.	The rotten iris was drawn out by pieces and cut off
115	Miss J. W. Am. N. Y. City.	25	Anæmic.	Half-soft. Ripe.	Maculæ Corneæ. Eye greatly sunken.	Feb., 1874.	Ap. of sec. $1\frac{1}{2}$ below marg. Vitreous presented.	Lens extracted with the capsule. Considerable loss of vitreous. Eye collapsed.

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS				
Hemorrhage into anterior chamber on fourth day; absorbed in three days.	15	$\frac{20}{100}$		$\frac{20}{70}$ 6 we'ks	
Slow healing of wound. Some capsular obstruction in pupil.	14	$\frac{20}{100}$			Five months after operation patient had a severe general disease, subacute irido-cyclitis. He died soon after.
	18	$\frac{10}{200}$		$\frac{10}{200}$	Result excellent considering the complications, especially the opacity of the cornea.
Violent fits of coughing. Inner corner of wound bulging. Slow closure.	11	$\frac{20}{200}$			
	23	$\frac{5}{200}$			Result all that could be expected. Vision improved by treatment of trachoma.
No reaction. Wound closed 3d day; reopened by injury the 4th, closed again the sixth. Pat. left with floating opacities in vitreous.	16	$\frac{20}{100}$			

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
116	C. D. Ger. Hoboken, N. J.	56		Hard. Ripe.		Feb., 1874.		Wound had to be enlarged with scissors. (No accident.)
117 118	E. W. Negress, N. Y. City.	90		Hypermature, chalky, thickened capsule. (Both.)	Chronic Conjunctivitis	Mch., 1874.	Sect. a little below transparent margin.	
119	A. H. M. Hebrew, Milwaukee, Wis.	26		Soft Traumatic (3 years)	Good.	Mch., 1874.	Apex of sec. 3 mm below corneal margin.	Capsule resisted cystotome, therefore extraction with capsule. No introduction of instruments. No prolapse of vitreous.
120	Dr. St. Am. Staten Island, N. Y.	79	Decrepit.	Hypermature.		Mch., 1874.	Ant. Capsule freely lacerated and lens easily removed.	The *opaque* centre of post. capsule was torn with sharp hook, but could not be extracted on account of protruding vitreous.
121	Mrs. M. R. Am. N. Y. City.	45		Mature.		April, 1874.	Centre of capsule cut out.	

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
Iritis and capsulitis plastica, leaving pupillary obstructions.	DAYS 35	$\frac{20}{100}$	Division by sickle-needle 13 weeks after extraction. No reaction. 5 days.	$\frac{20}{40}$	
Iritis leaving pupillary obstruction in both.	26	$\frac{5}{200}$ $\frac{10}{200}$		$\frac{5}{200}$ $\frac{15}{200}$ 6 we'ks	
Diffuse opacity of vitreous with circumcorneal injection from 3d to 15th day. One small synechia at inner angle of wound.	19	$\frac{20}{30}$		Excellent.	
Plastic capsulitis, producing a pupillary membrane.	37	$\frac{5}{200}$	3 months later iridectomy followed by hemorrhage. Discharged 6th day with	V $\frac{7}{200}$ later $\frac{20}{200}$	
	14	$\frac{20}{70}$			

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
122	J. W. Am. N. Y. City.	70	Feeble	Cataracta accreta.	Recurrent iritis for years 20 years ago. Pupils closed. $V\frac{1}{\infty}$ both for twenty years. Tn. Fc.	April, 1874.	Extraction R. Eye smooth. Counted fingers.	Some cortex left.
123	Mrs. E. P. Am. Westfield, Mass.	70		Hard. Ripe.		April, 1874.		
124	S. V. Negress, N. Y. City.	63	Bronchitis.	R. eye Hypermature		April, 1874.	Extraction with capsule. No introduction of instruments.	Escape of fluid vitreous.
125				L. eye Synchysis. (Complicated.)				Small section enlarged with scissors. Fluid vitreous escaped. Iridectomy made with great difficulty. Cataract extracted with hook. Some cortex left. About one-third of vitreous escaped. Eye collapsed.

Course of Healing Process and After-Treatment.	Length of Treatment.	V. at time of Discharge.	After-Operations	Ultimate V.	REMARKS.
Reaction inconsiderable. Coloboma obstructed by remnants of capsule and lens.	DAYS 20	$\frac{1}{200}$	6 months later irid'ctomy, yielding.................. V $\frac{5}{200}$ but revealing secondary cataract, which 3 weeks later was divided and depressed with Beer's knife. Recovered in 6 days	$\frac{15}{200}$	
	30	$\frac{20}{70}$	10 months later division of wrinkled capsule. No reaction.	$\frac{20}{20}$ 2 y'rs later.	
Some floating opacities.	2	$\frac{20}{200}$			
3d day suppuration in the vitreous. Panophthalmitis; atrophy of globe.	32	0			

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
126	Mrs. A. M. K. Am. N. Y. City.	50	Bronchitis. 20 yrs.	Hard. Ripe.		May, 1874.		Copious hemorrhage after iridectomy. The ant. chamb. emptied several times. A sponge was held on the wound for some time. (Accident.)
127	E. F. Heb. Baton Rouge La.	50		Half-soft. Ripe.		May, 1874.		
128	Mrs. J. B. Ger. N. Y. City.	64		Cataracta sublunata. (Complicated).		May, 1874.		After the section it was attempted to extract the lens by pressing it out with a curette applied to the outer surface of the cornea while keeping the wound open by depressing the posterior lip of the wound. The lens did not move. A sharp hook was then introduced, its point inserted into the lens from the posterior pole The cataract was readily drawn out, and the capsule followed with only one bead of vitreous.

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
Obstruction of pupil by pseudo-membrane.	DAYS 11	$\frac{10}{200}$	30 days after extraction, division of secondary cataract with falciform needle. Recovered in 5 days with	$\frac{20}{100}$	
	15	$\frac{20}{70}$		$\frac{20}{20}$, $2\frac{1}{2}$ y'r	
No reaction.	10	$\frac{20}{200}$			

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
129	Mrs. M. M. Am. Brooklyn, N. Y.	36		Morgagnian (Hypermature.)		June, 1874.	After the rupture of the capsule the milky corticalis escaped into the ant. chamb. It was removed, as cleanly as possible, with the nucleus.	
130	P. T. Am. N. Y. City.	56		Hard. Ripe.		June, 1874.		
131	D.S.H. Am. N. Y. City.	80	Decrepit.	Cataracta cystica, of 40 years' standing. (Hypermature.)		June, 1874.	Extraction with capsule without introduction of instruments, followed by the escape of a small quantity of vitreous.	
132	M. B. Ger. N. Y. City.	58		Morgagnian. (Hypermature).	Very myopic.	Oct. 1874.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS				
Mild iritis. Some synechiæ, and capsular opacities.	16	$\frac{20}{70}$			
On the sixth day, hurt his eye violently. Wound ruptured. An. cham. filled with blood. Gradual absorption. Synechiæ and opacities of pupil.	28	$\frac{3}{200}$	5 months after extraction, division of sec. cat. with sickle needle. No reaction. 5 days.	$\frac{20}{100}$	
Suppuration and hyalitis, and iritis. Ant. chamb. and iris cleared up, but pupil remained occluded.	13	$\frac{1}{\infty}$ F. c.			
	19	$\frac{20}{100}$			

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
133	M. B. Heb. N. Y. City.	51		Hyper-mature. Capsule thickened.	Always highly myopic.	Oct. 1874.		
134	J. O'N. Am. N. Y. City.	44		Hard. Ripe.		Oct. 1874.		
135	H. D. Am. N. Y. City.	63		Hard. Ripe.		Nov. 1874.		
136 137	J. M'C. Am. S. Sing, N. Y.	64		R. Hypermature. L. Hard. Ripe.		Nov. 1874.	R. extraction with capsule.	R. A single drop of vitreous.

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
Bulging incarceration of iris in outer corner of wound abscinded, without emptying ant. chamber. No reaction.	DAYS 23.	$\frac{20}{70}$	$1\frac{1}{2}$ years afterward, acute purulent iritis, (intense pain, pericorneal injection and impairment of S the first day; purulent disch. œdema of lids, chemosis, hypopyon, iris greenish, pupil plugged, $V\frac{1}{x}$ the second day. The prolapse was swollen, white, covered with adherent mucus. It was incised, the iris drawn out extensively and abscinded. Ant. chamb. emptied. From that moment, improvement ending in complete recovery. $V=\frac{20}{40}$.		
Small prolapse of iris at outer angle of wound.	12	$\frac{20}{70}$		$\frac{20}{20}$	
	14	$\frac{20}{70}$		$\frac{20}{20}$ ($1\frac{1}{2}$ year.)	
	18	$\frac{20}{70}$			
		$\frac{20}{100}$			

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
138	E. E. Am. N. Y. City.	70		Hard. Ripe.		Nov. 1874.		
139 140	Mrs. W. S. Heb. Wm's-burg, N. Y.	60		Hard. Ripe, both.		Nov. 1874.		
141	L. C. Ger. Hobo-ken, N. J.	52	Nerv-ous. Ple-thoric.	Hard. Ripe.	Eye very deep-set.	Nov. 1874.	Capsule cut out.	A few drops of *vitreous* after exit of lens by excessive pressure of patient.
142	J. P. Am. B'ling-ton, N. J.	69		Hyper-mature		Nov. 1874.		Some remnants of cortex left.
143	H. P. Ger. Flat-bush, N. Y.	64	Stout. Ple-thoric from drink-ing.	Hard. Ripe.		Nov. 1874.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS				
Iritis with complete closure of pupil. Iris drawn upward.	42	$\frac{2}{200}$	14 weeks after first operation, artificial pupil with Beer's knife and Tyrell's hook. Central, sharply defined pupil yielding S $\frac{15}{200}$. A thin membrane which spread across the pupil was divided four weeks later, yielding	$\frac{20}{70}$ and $\frac{20}{50}$ ($1\frac{1}{2}$ year.)	
After-hemorrhage in ant. chamber in both eyes, leaving in the right some pupillary opacity.	16	R. $\frac{20}{200}$ L. $\frac{20}{100}$		$\frac{20}{100}$ $\frac{20}{40}$ (4 mo.)	
Mild iritis.	28	$\frac{16}{200}$		$\frac{20}{100}$ (3 mo.)	
	19	$\frac{20}{100}$		$\frac{20}{40}$ (2 mo.)	
	13	$\frac{20}{100}$		$\frac{20}{20}$ ($1\frac{1}{2}$ yrs.)	

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
144	L. S. Ger. Elizabeth, N. J.	64		Hard. Ripe.		Dec. 1874.		
145 146	Mrs. J. Heb. N. Y. City.	80	Stout. Decrepit.	Hypermature both.	Deep-set.	Dec. 1874.		Section small in both. Expulsion difficult. Some cortex left in both.
147	Mrs. P. Heb. N. Y. City.	60		Hard. Ripe.		Dec. 1874.		
148	R. V. Am. B'klyn, N. Y.	50	Had had articular rheumatism several times. (Complicated.)	Posterior synechiæ		Dec. 1874.	Extraction with capsule. No instrument introduced.	
149	Mrs. E. P. Am. Westfield, Mass.	65		Hard. Ripe.		Jan. 1875.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 20	$\frac{20}{100}$		$\frac{20}{30}$ (3 mo.)	
Purulent keratitis and panophthalmitis in both.	35	0 0		0 0	
Plastic iritis with closure of pupil.	36	$\frac{1}{\infty}$	Five months later, iridectomy with Beer's knife and Tyrell's hook. Central pupil yielding	$\frac{20}{50}$	
Hyalitis on fifth day. Iritis. Pupil obstructed, clearing up. In the third week attacked with acute articular rheumatism, on account of which he desired to be discharged. His eye was improving and showed	21	$\frac{5}{200}$			Patient died six weeks after his discharge.
	25	$\frac{20}{30}$		$\frac{20}{20}$ ($1\frac{1}{2}$ yrs.)	Other eye operated on before. (See case 123).

No. of Case.	Name. Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
150	Mrs. M. M. Am. B'klyn, N. Y.	45		Half-soft. Ripe.		March 1875.		
151	Mrs. C. M. Am. Elizabeth, N. J.	59		Hard. Mature.		April, 1875.		
152	Mrs. M.A.S. Am. S. I. N. Y.	70		Hypermature.		May, 1875.		
153				Hard Ripe.				
154	Mrs. C. S. Am. N. Y. City.	50		Ripe. Large.		May, 1875.	Large section wholly in the limb. conjtv.	A small portion of iris near periphery fell before knife and was cut.

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
Mild Iritis.	DAYS 25	$\frac{20}{50}$			
	13	$\frac{20}{50}$		$\frac{20}{30}$ (2 mo.)	
	21	$\frac{20}{100}$ $\frac{20}{70}$		$\frac{20}{50}$ (5 mo.) $\frac{20}{30}$ (5 mo.)	
Purulent iritis from the second day. Wound opened. Ant. chamb. evacuated several times. Complete closure of pupil.	16	$\frac{1}{\infty}$		$\frac{1}{\infty}$	7 months later, cornea flat, indrawn scar, painful irido-cyclitis. Vision of other eye impaired, without physical changes, indicating sympathy. Antiphlogistic treatment. Inflammation soon ceased. Other eye healthy S $\frac{20}{20}$. No irritation since.

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
155	S. L. Am. Bridgeport, Ct.	50		Hard. Ripe.		May, 1875.		
156	L. C. Ger. N. Y. City.	52		Hypermature. Capsule thickened.	Myopic.	May, 1875.	Apex of section 1 mm. below corneal margin.	Lens extracted with capsule by means of a hook. Capsule burst, but the greater part of it was removed. A few drops of liquid vitreous escaped.
157	Mrs. M. M. Am. Brooklyn, N. Y.	55		Hard. Ripe.		May, 1875.		
158	J. F. Am. Fort Wayne Ind.	65		Immature. (Dark nucleus, cortical-is semi-transparent, capsule opaque.		May, 1875.	Large section, centre of ant. capsule removed.	

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 14	$\frac{20}{70}$		$\frac{20}{70}$ (10 mo.) Tn $1\frac{1}{2}$ with $+\frac{1}{2\frac{1}{4}}$	Reads 6 to 7 hours a day without any annoyance. Other eye blind.
Reaction very moderate.	18	$\frac{20}{100}$			
Mild but very obstinate irido-hyalitis.	34	$\frac{20}{100}$		$\frac{20}{30}$ (6 mo.)	
Mild iritis.	36	$\frac{20}{70}$			

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
159	Mrs. C. G. Ger. Hoboken, N. J.	64		Hypermature.		June, 1875.		
160	F. D. Ger. N. Y. City.	39		Half-soft. Mature.	Both eyes prominent, somewhat hydrophthalmic.	June, 1875.		An extraordinary amount of liquid escaped after the completion of the section.
161	W. B. Ger. Brooklyn, N. Y.	60		Hypermature.		June, 1875.		A drop of vitreous escaped on removal of cortical remnants.
162 163	W. B. Am. N. Y. City.	76		Hypermature with thick. capsule, both.		June. 1875	Capsule cut out.	*R.* A drop of vitreous while last portion of cortex was removed. *L.* Vitreous presented while cortex was removed. It receded as soon as pressure of the globe was discontinued.
164	Mrs. A. Mc. G. Am. N. Y. City.	60		Immature. Corticalis semi-transparent.		Sept. 1875.	Section large. The tough capsule was ruptured with difficulty.	Exit of lens tardy. Visual test negative. Cortex left.

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 19	$\frac{15}{100}$		$\frac{20}{50}$ (2 mo)	
	14	$\frac{20}{70}$			
Intense iritis.	46	$\frac{20}{70}$			
	14	R. $\frac{15}{100}$ L. $\frac{15}{70}$		$\frac{20}{50}$ $\frac{20}{20}$ (1 y'r).	
Purulent iritis.		$\frac{1}{\infty}$			

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
165	Dr. L. Ger. N. Y. City.	54	Stout.	Mature.	Highly myopic.	Sept. 1875.	Capsule cut out.	
166	M. A. C. Am. N. Y. City.	60		Morgagnian. [Hypermature.]		Sept. 1875.		
167	Mr. A. Am. Greenpoint, N. Y.	80		Hard. Ripe.		Oct. 1875.		
168	Mrs. A. R. Am. N. Y. City.	60		Hard. Ripe.		Oct. 1875.		
169	F. P. Ger. N. Y. City.	54		Hard, and shrunken. Capsule irregular [Hypermature.]		Oct. 1875.	Lens removed in capsule by large spoon depressing posterior lip, and rubber spoon pushing lens out by pressing on cornea.	Escape of some vitreous.

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 24	$\frac{20}{70}$		$\frac{20}{30}$ (4 mo.)	
Irido-cyclitis. Closure of pupil. Indrawn scar.	25	$\frac{1}{\infty}$		$\frac{1}{\infty}$	Ciliary region remained tender to the touch for ten weeks. No irritation of other eye.
Tardy closure of wound. No irritation.	16	$\frac{20}{40}$		$\frac{20}{20}$ (2 mo.)	
Slight iritis.	16	$\frac{20}{50}$		$\frac{20}{30}$ (9 mo.)	
No reaction.	15	$\frac{20}{100}$		$\frac{20}{40}$ ($2\frac{1}{2}$ mo.)	

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
170	Miss E. A. Ger. Ct.	58		Hard. Ripe.	Dacryo-cystitis chronica.	Oct. 1875.	Extrac. ith capule.	
171	Mrs. Chs. Am.	54		Hyper mature Capsule thickened.		Nov. 1875.	Capsule cut out.	
172	A. S. Heb. N. Y. City.	65	Feeble	Cataracta accreta Former irido choroiditis.	Functional examination satis-satisfactory	Nov. 1875.		Lens slightly dislocated by cystotome. Escape of vitreous.
173	Mrs. M. M. Am. N. Y. City.	60		Hard. Ripe. Catar. accret.	Posterior synechiæ. Functional examination normal.	Nov. 1875.		Bleeding in ant. chamb. Escape of vitreous.
174	S. W. Am. N. Y. City.	72		Hard. Ripe.		Nov. 1875.	Extraction with capsule.	
175	Mrs. H. M. Am. N. Y. City.	66	Exceedingly fat.	Catar. accret.		Nov. 1875.		Bleeding. Escape of vitreous.

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 16	$\frac{20}{70}$			The dacryo-cystitis was tr(ated 5 days before the extraction with injections of sulph. zinci in the sac, which improved the condition greatly.
Mild iritis.	15	$\frac{20}{200}$		$\frac{20}{50}$ (3 mo.)	
Suppuration in vitreous. Great pain. Indrawn scar.	7	$\frac{1}{\infty}$		$\frac{1}{\infty}$	
Suppuration in vitreous. Anterior chamber opened once daily for five days. Pupil closed.	22	$\frac{1}{\infty}$		0	
	13	$\frac{20}{70}$			
Suppuration of vitreous. Pupil closed by yellow substance.	29	0		0	

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
176 177	Gen. U. Am. Long Island, N. Y.	72		R. Morgagnian. L. Hard. Ripe.		Jan. 1876.		
178	J. S. Germ. N. Y. City.	44		Ripe.		Feb. 1876.		Escape of a few drops of vitreous after expulsion of lens by an awkward movement of patient.
179	Mrs. G. W. Germ. N. Y. City.	65		Hard. Ripe.		Mar. 1876.		
180	Mrs. S. N. Am. N. Y. City.	67		Hard Ripe.		Mar. 1876.		
181	M. T. Am. Long Island, N. Y.	56		Hard. Ripe.		Mar. 1876.		
182	M. W. Am. N. Y. City.	66		Hard. Ripe.		Mar. 1876.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 21	$\frac{20}{70}$ $\frac{20}{70}$		$\frac{20}{40}$ $\frac{20}{40}$ (6 w'ks.)	
Some floating opacities in vitreous, when discharged.	16	$\frac{20}{50}$			
	8	$\frac{20}{40}$			
Mild iritis, leaving a few filiform synechiæ and a thin pupillary membrane.	23	$\frac{20}{70}$	Ten weeks later S $\frac{20}{200}$, the thin wrinkled capsule was split with Beer's knife, yielding	$\frac{20}{100}$	Sight changed considerably, and on examination retinitis albuminurica was discovered.
A small part of incarcerated iris in one corner of the wound is removed, though showing no irritation.	19	$\frac{20}{30}$		$\frac{20}{20}$ (6 w'ks. 9 mos.)	
	14	$\frac{20}{50}$		$\frac{20}{40}$ (4 w'ks.)	

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
183	O. N. Am. N. Y. City.	46		Hard Ripe.		Apr. 1876.		
184	I. S. Germ. N. Y. City.	48		Hard Ripe.		Apr. 1876.		
185	S. S. Heb. N. J.	48		Traumatic. (Complicated.)	Synechiæ Funct. exam. normal.	Apr. 1876.		
186	C. M. Am. N. Y.	60		Hard Pipe. (Complicated.)	Myopia. Extensive choroidal atrophies, seen after recovery.	Apr. 1876.	Section very large.	
187	Mr. G. Germ. N. Y. City.	64		Hard Ripe.		Apr. 1876.		
188	Mr. S. Ger. Phil. Pa.	76	Nephritis and Bronchitis chron.	Hard. Ripe.		April, 1876.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
	DAYS 20	$\frac{20}{30}$		$\frac{20}{20}$ (6 w'ks.)	
	14	$\frac{20}{30}$			
	14	$\frac{20}{100}$		$\frac{20}{40}$ (10 w'ks.)	
.	21	$\frac{20}{200}$ with $+\frac{1}{7}$			
Irido-cyclitis, mild, but obstinate, with partial bulging of iris. Centre of pupil kept clear. Recovery, bulging disappeared.	33	$\frac{20}{100}$		$\frac{20}{50}$ (2 mos.)	
Iritis.	27	$\frac{20}{100}$			

No. of Case.	Name, Nativity, Residence.	Age.	General Condition.	Quality of Cataract.	Condition of Eye.	Time of Operation.	Execution of Operation.	Incidents of Operation.
189	Mrs. E. Ger. N. Y. City.	48		Hard. Ripe.	Myopic.	April, 1876.		
190	D. Ger. Union Hill, N. J.	70		Hard. Ripe. (Complicated.)	Highly myopic, hydrophthalmic eye. Other eye successfully operated on before showing extensive atrophic patches of choroid.	April, 1876.	In capsule.	Considerable loss of vitreous.
191	Mrs. S. Am. N. Y. City.	65		Hard. Ripe.		May, 1876.		
192	Mrs. H. Ger. N. Y. City.	76		Lens partially dislocated in anterior chamber (Complic't'd.)	Consecutive glaucoma acut.	May, 1876.	Lower section through cornea. No iridectomy. Exit of lens easy.	

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
Iritis a week after operation.	DAYS 27	$\frac{20}{70}$ $(+\frac{1}{7})$	2 months after operation, division of false membrane with Beer's knife. Yielding	$\frac{20}{40}$ 3 mos. later $\frac{20}{70}$	
Very tardy closure of wound on account of vitreous keeping a small portion of it gaping. The protruding little bead was cut off a few times. At last the wound closed.	32	$\frac{20}{200}$ without a glass.		$\frac{20}{70}$ Reads with $+\frac{1}{7}$ 3 mos.	Many atrophic patches of choroid. Opacities in vitreous.
	20	$\frac{20}{70}$		$\frac{20}{50}$ $1\frac{1}{2}$ mos.	
Central, round pupil.	6	$\frac{20}{40}$		$\frac{20}{40}$ 7 we'ks	Patient knew no cause of the dislocation. Stated that she had been blind 2 years. Of late the eye became inflamed.

No. of Case.	*Name. Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
193	Mrs. A. B. Ger. N. Y. City.	48		Hard. Ripe.		May, 1876.		
194	Dr. L. Ger. N. Y. City.	50		Hard. Ripe.	Myopic. Floating opacities of vitrea a year before operation.	May, 1876.		
195	Mr. T. Ger. B'klyn N. Y.	78		Morgagnian (Hypermature.)		May, 1876.		
196	Mrs. J. Am. N. Y. City.	55		Hard. Ripe.		June, 1876.		
197	E. R. Ger. N. Y. City.	68		Hard. Ripe.		June, 1876.	Section small. Expulsion slow, but complete.	

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
On the third day iritis set in, 5th day pus in pupil and ant. chamber. 6th day infiltration of part of flap. Flap incised, anter. chamb. emptied. 7th, reopened, chamb. filled with blood. Then gradual absorption and clearing of pupil.	DAYS 25	$\frac{1}{\infty}$		$\frac{2}{200}$ 2 mos. $\frac{20}{200}$ 3 mos.	
	15	$\frac{20}{50}$		$\frac{20}{30}$ 5 we'ks	
	18	$\frac{20}{200}$		$\frac{20}{40}$ 4 we'ks	
	7	$\frac{20}{40}$			
	9	$\frac{20}{30}$			

No. of Case.	*Name, Nativity, Residence.*	*Age.*	*General Condition.*	*Quality of Cataract.*	*Condition of Eye.*	*Time of Operation.*	*Execution of Operation.*	*Incidents of Operation.*
198	Mrs. S. Ger. N. Y. City.	49		Hard. Ripe.		June, 1876.		
199	L. L. Ger. N. Y. City.	68		Hard. Ripe.		June, 1876.		
200	Mr. A. Ger. N. Y. City.	48		Hyper-mature.		June, 1876.		

Course of Healing Process and After-Treatment.	*Length of Treatment.*	*V. at time of Discharge.*	*After-Operations*	*Ultimate V.*	*REMARKS.*
Capsulo-iritis. Hypopyon. Afterward whole ant. chamber filled with yellowish bloody exudation, stationary for nine days, then gradually absorbing, leaving dense pupillary membrane.	DAYS 32	$\frac{1}{\infty}$	4 months later artificial pupil with Beer's knife. The corneal wound was small and it required some effort to withdraw Tyrell's hook. Artific. pupil small, clear; corneal wound irritated for two weeks.	$\frac{20}{200}$ 6 we'ks	
	12	$\frac{20}{70}$		$\frac{20}{20}$ (4 w'ks.)	
	22	$\frac{20}{50}$			

From the foregoing tabular statement, the influence which different factors have on the result of the operations may be more or less conclusively derived. I shall successively consider these factors as follows.

I. NATIONALITY.

TABULAR STATEMENT.

Nationality.	*Number of Operations.*	*Results.**		
		Good.	*Moderate.*	*Failures.*
Americans,	88	73; 83%	4; 4.5%	11; 12.5%
Germans,	69	62; 89.8%	2; 3%	5; 7.2%
Hebrews,	20	15; 75%	1; 5%	4; 20%
Irish,	13	10; 77%	2; 15.3%	1; 7.7%
French and Spanish,	4	3; 75%	——	1; 25%
Negroes,	6	1; 16.2%	4; 66.6%	1; 16.2%
	200	164; 82%	13; 7.5%	23; 11.5%

This table shows a markedly reduced rate of success in the Hebrew and Negro nationalities, while in the others the differences of success are hardly marked enough to demonstrate more favorable conditions in the one than in the other nationality. The number of operations performed on Hebrews and Negroes was, however, too small to assume that cataract operations in these races offer a worse chance than in others. The four cases of failure in the Hebrew patients are accounted for by special causes: in *the first*, the operation was laborious, the lens was extracted with a spoon, and vitreous escaped; the *second* and the *third* referred to hypermature cataracts in a fat

* As *good* results are reckoned cases of S $= \frac{20}{20}$ to $\frac{20}{200}$.
As *moderate* results are reckoned cases of S $= \frac{19}{200}$ to $\frac{2}{200}$.
As *failures* results are reckoned cases of S $< \frac{2}{200}$.

and feeble woman of eighty years, who was fidgety and unmanageable. The expulsion of the lenses was difficult. The *fourth* case was a cataracta accreta in an eye which had suffered from irido-choroiditis.

In regard to the negroes I am not prepared to state that they, as a race, offer the same ratio of success as the whites. Operations in the negro, other circumstances being equal, seem to be followed by more irritative processes than in the white man.

II. AGE.

The influence which the *age* of the patients had on the final results is shown in the following table.

Age in Years.	*Number of Operations.*	*Results:*		
		Good.	*Moderate.*	*Failures.*
20 to 29	3	3; 100%		
30 to 39	10	10; 100%		
40 to 49	27	23; 85%	2; 7.5%	2; 7.5%
50 to 59	53	45; 85%	3; 5.6%	5; 9 4%
60 to 69	64	52; 81%	2; 3.4%	10; 15.6%
70 to 79	36	30; 83.3%	4; 11.1%	2; 5.6%
80 to 90	7	1; 14.3%	2; 28.6%	4; 57.1%

This table shows that up to the age of 40 years, all operations were followed by complete success. From 40 to 80 years, the percentage of good results remained almost the same, varying between 85 per cent and 81 per cent, whereas after 80 it abruptly sank to 14.3 per cent. If we disregard the column of the moderate results, and examine that of the failures, the age of the patients seems to have a decided influence on the results, so that the ratio of losses increases with advancing years, being 0% until the age of 39 years, 7.5% between 40 and 49 years, 9.4% between 50 and 59 years, 15.6% between 60 and 69 years, 5.6%

between 70 and 79 years, and 57.1% between 80 and 90 years. The table shows a steady increase of the failures from 40 to 69 years of age, but then there is a marked—evidently accidental—diminution during the years from 70 to 79, and again an extraordinary rise after 80 years. Half of the cases (5 out of 10) of failure in the years from 60 to 69 referred to complicated cataracts and impure operations. Each of the four cases of loss in patients from 80 to 90 years showed some accident in the operation: the first, introduction of a large spoon, and escape of vitreous; the second, escape of vitreous; the third and fourth, difficult exit of lens with remaining rests of cortex.

The two cases of moderate success referred to the two eyes of a negress (case 117 of the table), whose age could only approximately be ascertained. She was led to the clinique by an old man who showed her the greatest kindness. When we asked him how old his wife was, he answered: "She is not my wife, but my mother, and I am 70 or 71." Both operations were smooth, yet followed by adhesive iritis.

It seems not surprising that the chances of a successful cataract operation should diminish with advancing years. The older the person, the more the structure and function of his eyes must fall short of their standard in youth and vigorous manhood, since a multitude of unfavorable conditions surround even the most felicitously situated among us. In general, we may expect that the older the patients the more complications accompany the cataract, the more difficult and impure are the operations, the less speedy and complete is the recovery, the more unfavorable are the results. That this, as a general proposition, is true, I have little doubt, though the numbers in this and former reports are not large enough conclusively to show the deleterious influence of advancing years. We all have seen old people make easy and perfect recoveries from cataract extractions, but in what percentage of the cases does this occur? If we speak of the prognosis of cataract operations in old age, we should count all the cases as they come before us, and not exclude the complicated cases, since many of the complications are qualities inherent to old age; for instance, a relaxed condition

of the conjunctiva and probably of other coats of the eye. Senile involution, which is so conspicuous in many parts of the eye, is certainly an unfavorable factor in the prognosis of cataract operations.

III. QUALITY OF CATARACT.

I shall distinguish, as in former reports, four kinds of cataract: *mature*, *immature*, *hypermature*, and *complicated*. I have called mature all cataracts in which the opacification was complete, either soft cataracts or hard, or—which is very frequent—a hard nucleus surrounded by soft corticalis, the so-called cataracta semi-mollis, which word, in the table, I have literally translated with half-soft. The period of complete opacification is not always the most favorable to operate in, since the lens may be considerably swollen by imbibition. On account of the shallowness of the anterior chamber in this condition, the knife encounters two obstacles on its way: the bulging iris—and the anterior capsule. It is difficult to avoid the iris immediately after the puncture, and still more difficult before the counterpuncture is effected. Moreover, in the avoidance of these obstacles, we are apt to make the counterpuncture too far in front, in which case the section becomes irregular and too short. *Arlt* very justly remarks that this period of swelling by imbibition should have passed before the extraction is undertaken.

As *immature* cataracts are entered those in which the cortical substance was still more or less transparent. Such cataracts can seldom be cleanly removed, and only for very forcible reasons should their extraction be attempted. I have, like many others, been frequently punished for violating this rule.

Hypermature cataracts are those which show symptoms of disintegration, such as thickening of the capsule, white, fatty or milky-looking, chalky or crystalline patches. The majority of Morgagnian cataracts, and also the cystic cataract, are classified under this head, though many of them, especially the cystic variety, are complicated with diseases of the inner membranes.

As *complicated* cataracts I have entered only those in which some ocular disease of importance existed in conjunction with

the cataract; for instance, atrophic conditions of the iris, choroid, retina and optic nerve, synchisis, adherent leucoma, and so forth; whereas ordinary cases of myopia are not included, since they give no worse prognosis than the common cataract. One case of large zonular cataract (No. 85), in a man of 43 years of age, is entered as an immature cataract. The extraction had a poor result, and the long-continued iritis made me fear sympathetic ophthalmia, which, however, did not occur.

The following tabular statement shows the *influence of the quality of the cataract on the course of the operation and on the final results.*

Quality of Cataract.	*Number.*	*Operation:*		*Result:*		
		Smooth.	*With Accidents.*	*Good.*	*Moderate.*	*Failure.*
Mature,	128; 64%	112; 87.5%	16; 12.5%	114; 89%	4; 3.2%	10; 7.8%
Immature,	7; 3.5%	1; 14.3%	6; 85.7%	4; 57%	1; 14%	2; 29%
Hyp'rmat'e	48; 24%	30; 62.5%	18; 37.5%	40; 83.2%	4; 8.3%	6; 12.5%
Complica'd	17; 8.5%	7; 41.2%	10; 58.8%	8; 47%	4; 23.5%	5; 29.5%
TOTAL,	200; 100%	150; 75%	50; 25%	164; 82.5%	13; 7.5%	23; 11.5%

The first row shows a rather low figure for the simple, mature, uncomplicated cataract, namely, 64%, whereas the hypermature cataracts were relatively frequent, viz., 24%. The influence which the quality of cataract exerted on the course of the operation is clearly exhibited in the second and third rows. The operations for mature cataracts were accompanied with accidents in 12.5% of the cases, for hypermature cataracts in 37.5%, for complicated cataracts in 58.8%, and for immature cataracts with 85.7%. The final results of the operations show a similar proportion: 89% perfect results in mature cataracts, 83.2% in hypermature, 57% in immature, and 47% in complicated cataracts. The imperfect results and failures are the least frequent in mature cataracts; then follow, in the order of fre-

quency, the hypermature, immature, and complicated cataracts. The table shows that the immature cataracts yielded surprisingly unfavorable results, nearly as unfavorable as the complicated cataracts. This shows the great responsibility the operator takes on himself when, by inattention, indifference, weakness, or professional jealousy, he is led to extract an immature cataract. I make it a rule not to operate as long as, on ophthalmoscopic examination, the fundus yields a red reflex, however faint it may be; furthermore, as long as the patient is able to count fingers, after dilatation of the pupil, and as long as, by oblique illumination, in combination with a magnifying glass of great aperture, it can be ascertained that a part of the corticalis is still transparent. In such cataracts the semitransparent portions of the cortex adhere so tenaciously to the capsule that the most judicious and persevering efforts may fail to remove them. It is sometimes exceedingly difficult to withstand the entreaties of patients who have travelled hundreds and thousands of miles. They see hardly enough to walk about alone, and the operator, instead of telling them to go home again and wait till their cataracts are fully mature, is apt to listen and yield to their entreaties to operate at least on one eye. The result of such a proceeding is seen in the second horizontal column of the foregoing table. There were, it is true, only 3.5% of immature cataracts, but in 85.7% of them the operation was accompanied by unfavorable accidents, at the head of which was the leaving of a greater or less quantity of cortical substance in the eye. Only 57% of these eyes obtained good vision, 14% moderately good vision, and the failures have reached the high number of 29%. That I, however, am not the only one who, in this matter, yielded to temptation and fell, may be seen from the following example.

Some years ago, a German, about 55 years old, residing in Boston, wanted me to operate on one of his eyes. This eye suffered from a cataract the nucleus of which was completely opaque, but the outer layers of the cortex were translucent. A faint red reflex was gained from the fundus, and the patient could with this eye count fingers at a distance of three feet, while the vision of the other was still tolerably

good. I told him his cataract was not ripe, and he should wait. He did not wait, but sailed for Europe. Six months later, he came back to me with a letter from an excellent German oculist, exemplifying anew the old story. The patient had travelled over 3000 miles to have his cataract removed, and did not want to return to America with the cataract in his eye. The oculist yielded, the expulsion of the lens was laborious and incomplete ; severe and prolonged iritis with closure of the pupil followed. When I saw the patient again, the eye operated on was collapsed and hopelessly blind.

While a student in London, I saw an excellent operator extract many an immature cataract. I expressed my astonishment, and he answered: "These people will be operated on. There is a keen competition in the city. If I send them away, telling them to wait, somebody else will operate on them." Such principles can, without damage to their reputation, be practised only by surgeons of hospitals, the old popularity of which covers, with the kind mantle of charity, many a sin of those "whose gratuitous services to the poor are inestimable," as the usual phraseology runs.

IV. CONDITION OF THE EYE.

Under this head there are some interesting observations noted. They do not easily admit of a statistical arrangement, but their nature and consequences can be conveniently studied by going over the general table.

V. THE TIME OF THE OPERATION

does not give rise to any remarks of importance. I have been taught that the hot season is unfavorable for cataract extractions. To this rule I have always adhered, and if I cannot demonstrate that the heat in itself is an unfavorable agent as to the healing of wounds of the eye, I can appreciate how unpleasant it must be, during the "heated term," to lie quiet, with bandaged eyes, from 4 to 7 days. Some of the patients who had been operated on in June, July, or August, were uncomfortable and restless from the heat, which, no doubt, had a bad influence on their cure.

VI. EXECUTION OF THE OPERATION.

A. *Instruments.*

The *knife* which I prefer is shaped like that of Lüer, but its surfaces are slightly concave, like those of a razor. I recommended these knives four years ago. They are unsurpassed in convenience, and their edge can be made sharper than that of the knives with flat surfaces (Lüer and others), and much more than those with convex surfaces (V. Graefe). They are perfectly reliable as concerns strength, and do not favor the escape of aqueous, as has, by theoretical reasoning, been pretended. I have given these knives a fair trial, and can repeat my recommendation.

Several forms of *iris-forceps* are in use. I have no preference for any one of them. The iris, which almost always protrudes, can be conveniently seized and secured with any kind of forceps, and it is a matter of practice with each operator to find out that form which will render him the best services.

I am very careful to have the *iris scissors* perfectly sharp and move evenly to the very point, so as to avoid the least bruising of the iris while cutting it.

I use Von Graefe's *cystotome* for the division of the capsule, and am very particular that its point and small cutting edge be of the utmost sharpness. An imperfectly sharp cystotome is apt to dislocate the cataract, and divide the capsule more in the way of tearing than of cutting. From numerous reactive processes of the capsule which I have closely watched and studied, I conclude that the capsule, like the iris, bears clean cutting well enough, but reacts unpleasantly on being torn with a blunt instrument.

For the expulsion of the lens I use a *hard-rubber spoon*, the blunt edges of which are pressed on the lower part of the cornea. (All my remarks refer to an upper section, unless a section in another direction be specially mentioned.) The edges of the spoon should be rounded and perfectly smooth; its form is indifferent. In the great majority of cases I press, during the passage of the lens, the posterior lip of the wound gently backward with a *broad silver spoon*. If the cataract cannot

be expelled in the usual way, and I am sure that the section of the cornea and the division of the capsule are sufficiently large, especially if the vitreous escapes, I introduce the same spoon slowly behind the cataract and extract it. A spoon *almost as broad as the lens* is the most reliable instrument in the so-called "accouchement forcé" of the cataract. If the cataract is hard, and cannot be removed by external pressure, a *sharp hook*, moderately curved and not too short, may be introduced behind the lens, implanted into the nucleus, and the lens thus drawn out.

B. *Mode of Operating.*

As regards the

Locality of the Section,

the experience gained by these last two hundred extractions tends to show that the advantages of a peripheric section, that is, one implicating the corneal tissue as little as possible, are more than counterbalanced by its dangers. Among these dangers I will mention the following: 1. It facilitates prolapse of vitreous, with all its injurious consequences; 2. It is more apt to produce incarceration of the iris and capsule of the lens than a corneal section; 3. Its reactive processes readily extend to the ciliary body, thus producing prolonged irido-cyclitis, and sometimes even sympathetic ophthalmia. My notes are not detailed enough to furnish numerical evidence of these propositions, but I have observed the facts, and they are deeply impressed on my mind. There was no instance of sympathetic ophthalmia in these two hundred cases, but such an example came recently under my observation, and the experience was terrible.

The main advantage of the peripheric section, as has always been asserted, consists in the greater immunity of the flap from sloughing. It was *Jacobson*, of Königsberg, who transferred the section from the cornea into the sclero-corneal juncture, because the tissue of the sclerotic has less tendency to suppuration than the cornea. He supported his recommendation by the results of 100 peripheric operations, of which he had lost only one eye. Jacobson's argument and practice have not been corroborated by more extensive experience. In the two hundred

extractions here under consideration, six cases of failure from primary suppuration of the flap were noted. In three of them—Nos. 9, 21, and 37—the section was strictly in the sclero-corneal juncture, being a regular Graefe's peripheric linear section, free from pathological complications and operative accidents. In the fourth—No. 6—the operation was smooth, the section peripheric, but small. In the fifth and sixth—Nos. 145 and 146—the section was peripheric, but small, and some cortex was left behind. We see that all the instances of primary suppuration of the flap occurred in cases where the section was peripheric. On the other hand, special notice is made of cases—Nos. 98, 102, 103, 108, 110, 111, 115, 119—in which the section encroached considerably, one to three millimetres, upon the transparent cornea, and in all of them there was no suppuration in the flap, and the results were good. If we consider these contrasting conditions as proof and counterproof, and attach no more value to them than the smallness of the numbers warrants, we may safely draw from them at least this inference : Suppuration of the flaps occurs as well after a peripheric as after a corneal section. Von Graefe also, in his later publications, lays less stress upon the periphericity of the wound than upon its linear direction. Upon the same principle are based the methods of *Liebreich* and *Lebrun-Warlomont*.

The Size of the Flap

is of the greatest importance. It is self-evident that the larger a wound, the greater is the reaction from it, other things being equal. We should, therefore, make no section larger than the easy expulsion of the cataract in a given case requires. The mathematical rule that a distance of 9.5 millimetres between the internal points of puncture and counterpuncture is sufficient for the ready exit of the largest cataract, has led to an operative technique which is minutely described in text-books and pamphlets, and need not here be repeated. But since, in shaping a section, we cannot measure it with mathematical accuracy, it will happen that the section becomes either too large or too small, and of these two errors the latter is infinitely the worse. All authors who write from personal

experience dwell on the numerous dangers of an insufficiently large section, and though I have always fully appreciated these dangers, there is in these last two hundred cases a certain number (4) where the section was noted as being too small, and the loss of the eye was attributed to this defect.

The *Excision of the Iris*,

the second step of the operation, was always made large and with particular care to avoid *incarceration of the iris* in the corners of the wound. And yet, when, after the completion of the operation, no iris could be detected in the wound, and even when the sphincter edges were clearly visible in the anterior chamber, it has happened that some days later a small prolapse of iris made its appearance. The unpleasant consequences of these angular incarcerations have been pointed out by many operators. My experience on the course which these prolapses may take is as follows.

1. A great number of them have no marked effect on the healing of the wound, nor on the result of the operation, and *remain permanently quiet*.

2. Many others *cause irritation:* injection and swelling of the tissue around the corner of the wound, turbidity of the aqueous, plastic iritis, pupillary membranes. Sometimes a cystoid scar forms around them, and remains, for a long time, subject to relapses of acute inflammation, lasting between 4 days and a week. I have not seen that glaucoma develops from this condition. To avoid any injurious consequences arising from these small incarcerations of iris, I have of late always removed them as soon as they showed any inflammatory irritation. This I did as early as three days after the extraction, and at any period afterward, whenever they became troublesome. The little operation is easy, and I have never seen any bad results from it. With a Graefe's knife I freely split the conjunctiva which covers the prolapse, seize the iris with a pair forceps, draw it out as far as possible, and cut it close to the sclerotic. The aqueous humor always escapes. When the imprisoned iris is markedly raised, it may be better to cut it away as any other small staphyloma, but it will be necessary to remove, with a forceps, all

the iris that is left in the wound. Incarcerated iris of many years' standing need not detain us from performing operations for secondary cataract, should any such become advisable. On a case of that kind I operated only a few weeks ago. The two eyes of an old lady, Mrs. B. Fife—Nos. 93 and 94 of the table—had been operated on three years and a half previously with good result. Two months ago she returned, complaining that, of late, she could not see so clearly as at first. Thin, irregularly dense membranes spread across both pupils, and the vision was reduced to $\frac{10}{200}$. In each eye there was a small prolapse of iris in one corner of the wound. That of the right was about as large as a pin-head, that of the left was smaller. Through both pupillary membranes a crucial incision was made with a broad sharp needle. No reaction in the eyes; pupils splendid. On the third day, the prolapse of the right eye and its surroundings began to be red and a little raised. This condition was a little more pronounced on the fourth day. I, therefore, removed the protruding iris in the manner above described, and in 4 days all irritation was over, S. was $\frac{20}{50}$ in the right and $\frac{20}{40}$ in the left eye.

3. In some cases *purulent iritis* occurs a long time after the operation. Dr. Steffan described such a case. (Report of his Ophthalmic Institution, 1873 to 1874.) A woman of 63 years of age had been operated on for cataract by Von Graefe's method with excellent result, but iris was inclosed in one corner of the wound. Two years and four months later the eye was destroyed by spontaneous purulent irido-cyclitis, the cause of which, as Dr. Steffan alleges, was the incarceration of the iris.

A similar case came under my care last year, in which the impending destruction of the eye was averted by immediate removal of the prolapse. As the case seems to be of great importance, both as to the pathology and therapeutics of the conditions under consideration, I will report it in detail.

James O'Neil, of New York, æt. 44, in Oct., 1874, had been operated on his right eye for cataract, according to Von Graefe's method (Case 134). A small prolapse of iris at the outer corner remained, causing no disturbance. The vision at the time of his discharge from the Hospital

was $\frac{20}{70}$, and soon increased to $\frac{20}{20}$. Several times, after an exposure, his eye was a little red and sensitive, but always became well again in a day or two. On Jan. 26th, 1876, however, he took a severe cold by wetting his feet. In the night he felt intense pain in his eye, which continued during the next day, with rapid diminution of sight. I saw him at 8 P.M. on Jan. 27th, that is, 30 hours after the exposure. His eyelids were red and greatly swollen, the conjunctiva chemotic, and there was copious, hot, sero-purulent discharge. The prolapse of iris and the surrounding tissues were swollen and yellowish-white. The iris was greenish, the pupil narrowed and completely plugged by a yellowish dull substance; the aqueous was turbid; there was hypopyon of two millimetres in height. The tension was increased, and the vision reduced to mere perception of light. I was convinced that the incarcerated iris, acting like a foreign body, was the starting point of the purulent iritis. The inflammation, I imagined, produced in the prolapse similar conditions as we witness in strangulated hernia. Believing that only the immediate removal of the imprisoned and inflamed part could save the organ, I at once went home, called my assistant, Dr. A. Alt, and with him performed the operation, half an hour later. The swollen prolapse was freely incised, seized with the forceps, drawn forward, and cut away. The anterior chamber was emptied. I applied the ordinary flannel-charpie bandage, and ordered instillations of atropia. The patient felt at once relieved. His pain had disappeared. He passed a good night. When I saw him the next morning, the swelling of the lids had diminished, the hypopyon had disappeared, the chemosis and the plugging of the pupil were as the day before; the wound was whitish infiltrated; the tension of the globe had become normal; sight no better. During the next two days the symptoms somewhat abated. I ordered five leeches to the temple, and a thorough aperient. The fourth day no œdema of lids, pupil still cloudy, Tn, S $\frac{1}{\infty}$; wound bulging; but patient felt comfortable, and the discharge was purely serous. From that time the improvement progressed steadily; the wound collapsed, and the pupil gradually cleared up from the sides. On the 7th of February, the prolapse had disappeared, the wound was closed, the anterior chamber had its natural depth. The patient could count fingers at the distance of half a foot. There was still intense circumcorneal injection, and the iris still looked dull and discolored. I again ordered the application of leeches to the temple. From the 9th, there was a steady subsidence of all the symptoms. The

pupil became black, the sclerotic white again. On February 19th, twenty-three days after the operation, he could count fingers at the distance of three feet; on March the 2d, at twenty feet; on March the 23d, S was $\frac{20}{100}$ and $\frac{20}{70}$. Four weeks later, that is, three months after the operation, it was $\frac{20}{40}$, and his eye was free from all irritation. A slight pupillary opacity was left. The cataract in his other eye was then removed (case 183), resulting in $S=\frac{20}{30}$ after two weeks, and $\frac{20}{20}$ after six weeks. He has had no annoyance from either eye since.

The case is certainly one of the most suggestive of the whole series.

The *Division of the Capsule*

was always done with a cystotome, the point of which was passed first along one side of the remainder of the natural pupil and its extension, then along the other side, and the periphery of the capsule behind the coloboma. The cystotome was then pushed again to the lower edge of the pupil, slightly turned, so as to grasp the circumcised quadrangular piece of capsule and extract it. Sometimes the little piece of capsule was on the point of the instrument, and could, by the microscope, be identified. When the centre of the capsule was thickened, and, after its circumcision, did not come out on the point of the cystotome, it was extracted with a pair of delicate forceps. In the majority of cases the circumcised piece of capsule came out together with the cataract. Even if we did not find it, its absence from the eye could be demonstrated afterward by oblique light, which rendered the edges of the capsular defect quite conspicuous.

The reactive processes on the part of the lacerated capsule, to which I have always paid a good deal of attention, are quite frequent, and in some cases very serious. They shall be spoken of hereafter.

The *Expulsion of the Lens*

was effected by pressing with a rubber spoon on the lower edge of the cornea, at first directly toward the centre of the globe, then following the passing cataract so as to evacuate, if possible, nucleus and cortex together. During this time I facilitated the opening of the wound by gently pressing the posterior lip backward, while an assistant steadied the globe with a pair of

fixing forceps. When I found that the capsule was freely divided and the exit of the cataract retarded by an insufficient section, I enlarged the wound at one corner with a strong and sharp pair of strabismus scissors.* Sometimes the conjunctival flap is an obstacle to the ready slipping out of the lens, and should, in such cases, be incised with scissors.

The *Removal of Remnants of Cortical Substance* was always effected by rubbing with the lids in the well-known manner; never was a Daviel's spoon or any other instrument introduced into the eye for that purpose. I prefer leaving some cortex in the eye to attacking it with a spoon. My experience from the days when I used a Daviel's spoon has been that those remnants which I was not able to remove by rubbing, could also not be removed with the spoon. I dread scraping the interior of an eye, however gently people tell you they can do it. Sometimes a piece of thickened capsule, with some lens matter adherent to it, was, after the exit of the cataract, removed with a pair of Mathieu's forceps.

In eleven cases the

Cataract was removed together with the Unbroken Capsule.

This procedure, I think, is indicated when the suspensory ligament is torn or frail, as in tremulous and certain hypermature cataracts, which may be recognized by a hydrophthalmic condition of the globe, abnormal depth of the anterior chamber, slight dislocation of the lens. In some cases the former condition of the eye, if known by previous examination, for instance high degrees of sclero-choroiditis, synchisis corporis vitrei, furthermore the comparison with the other eye, and so forth, will aid the diagnosis. In such cases I make the section very large and less peripheric than usual, in order to avoid or restrict, as much as possible, the prolapse of vitreous. In one case the lens was removed with a large spoon; in the ten others, the crystalline body was removed without the introduction of a traction instrument. After the section had been completed and the

* There are more bad strabismus scissors in the world than good ones, and it is not quite easy to find such as will answer the requirements of enlarging a cataract section without bruising.

iridectomy made, the eye being steadied with fixing forceps by an assistant, I held the posterior lip of the wound backward with a large spoon, and expelled the lens in the usual manner, by pressure upon the cornea from below upward. The results of these operations, considering the unfavorable conditions of the cases, were rather satisfactory. One eye was lost, in another the vision obtained was moderate ($\frac{5}{200}$), in the nine others it was good. The following synopsis will afford an easy review of these rather difficult cases.

No. 109. Pat. 71 years. Capsule resisted Weber's double hook. Lens with capsule extracted by large spoon. Escape of vitreous. Reaction slight. S $\frac{20}{70}$.

No. 115. Pat. 25 years. Cataract half-soft. Vitreous presented after iridectomy. Lens with capsule extracted, considerable loss of vitreous. No reaction. S $\frac{20}{100}$.

No. 119. Pat. æt. 26. Extr. with capsule. No prolapse of vitreous. No reaction. S. $\frac{20}{30}$ after 19 days.

No. 124. Negress, æt. 60. Escape of vitreous after exit of lens. Healing without disturbance. Floating opacities in vitreous. S $\frac{20}{200}$ in 32 days.

No. 131. Decrepit person, æt. 80. Cystic cataract of 40 years' standing. Prolapse of a moderate quantity of vitreous. Suppurative iritis and hyalitis. Occlusion of pupil. Perception of light only preserved. *Failure.*

No. 136. Patient 64 years of age. Cataract hypermature. Escape of a single drop of vitreous. No reaction. Vision $\frac{20}{70}$, 18 days after operation.

No. 148. Pat. aged 50, of Brooklyn. Subject to articular rheumatism. No accident during operation. Iritis and hyalitis set it on fifth day ; improving in third week. A new attack of articular rheumatism in third week. Discharged on 21st day with S $\frac{5}{200}$. *Result moderate.* Patient died of rheumatism six weeks afterward.

No. 169. Pat. aged 54. Cataract hard and shrunken ; capsule irregular. Slight prolapse of vitreous. No reaction. S $\frac{20}{100}$ at time of discharge, 15 days after operation ; $\frac{20}{40}$ two months later.

No. 170. Pat. aged 58 ; chronic dacryo-cystitis. No accident. No reaction. S $\frac{20}{70}$ at discharge.

No. 174. Pat. æt. 72. Cataract hard, ripe. No accident, no reaction. S $\frac{20}{70}$ at discharge.

No. 190. Pat. aged 90. Hydrophthalmic eye. Considerable loss of vitreous. Very tardy closure of wound, S $\frac{20}{200}$ without a glass, 32 days after extraction; $\frac{20}{70}$ two months later. Reading glass + $\frac{1}{7}$. Extensive atrophic patches of choroid, and floating opacities in both eyes.

INCIDENTS DURING THE OPERATION, AND THEIR CONSEQUENCES.

Among the 200 operations 150, that is 75%, were perfectly smooth and without any unusual features. In 97, that is in 65%, of these 150 smooth operations, recovery took place without any inflammatory or other disturbance.

The primary results of the 150 smooth operations were 127 good results, 15 moderate results, and 8 failures. Of the 15 moderate results 8 were, by after-operations, converted into good results, and one into a failure. Of the 8 failures (*i. e.*, S $\frac{1}{\infty}$) two were converted, by after-operations, into good results, so that the final statement of the 150 smooth operations was as follows:

Good results: 136 eyes, *i. e.*, 90.6%.
Moderate results: 7 eyes, *i. e.*, 4.7%.
Failures: 7 eyes, *i. e.*, 4.7%.

Of the 200 extractions 50, that is 25%, were anomalous, *i. e.*, accompanied with accidents. In 12 of them, that is in 24%, the recovery was undisturbed by inflammation or irritative reaction of any kind.

The primary results of the 50 anomalous operations were: good 23, moderate 10, failures 17. After-operations converted 1 failure into a moderate, and 5 moderate into good results, so that the final statement of the complicated operations was:

Good results: 28 eyes, *i. e.*, 58%.
Moderate results: 6 eyes, *i. e.*, 10%.
Failures: 16 eyes, *i. e.*, 32%.

If we put these numbers together in a table, a comparison will show, at a glance, how much the rate of success is lowered by accidents during the operation.

Operations.		*Recovery:*		*Results:*		
		Smooth.	*Disturbed.*	*Good.*	*Moderate.*	*Failures.*
Smooth,	150 ; 75%	97 ; 65%	53 ; 35%	136; 90.6%	7; 4.7%	7; 4.7%
With accidents,	50 ; 25%	12 ; 24%	38 ; 76%	28; 56%	6; 12%	16; 32%
TOTAL,	200; 100%	109 ; 54.5	91; 45.5%	164; 82%	13; 7.5%	23; 11.5%

This statement of 4.7% of failures after smooth operations, and 32% after operations accompanied by accidents, would be a severe verdict against the operator, were *all* the accidents *his* fault. Some of the accidents are unavoidable, or almost unavoidable; for instance, hemorrhage from the iris, or into the vitreous (no example in our present series of cases), the numerous more or less prejudicial incidents and manœuvres intrinsically connected with the removal of hypermature and complicated cataracts, as the introduction of traction instruments with all their bad consequences. The extraction with the capsule, for certain cataracts the least hazardous operation, is almost always accompanied by loss of vitreous. In the preceding tables are counted even the slightest incidents during the operation that could possibly have any influence on the cure. That they may be compared with other publications the basis of which is different, I will put them together in groups, and add such remarks as appear of interest and importance.

Synopis of Incidents during the Operation.

1. In case 154, a part of iris near the periphery *fell before the knife* and was cut off. Lens large. Purulent iritis. S $\frac{1}{\infty}$.—Cutting of a central part of the iris is commonly done without much harm; cutting of a peripheric part may be more dangerous, since the iris is pressed against the hard sclerotic and into the wound. I would, in such cases, try to extend the iridectomy beyond the bruised part of the iris.

2. In case 126, *unusually copious hemorrhage* followed the iridectomy. It was finally arrested by emptying the anterior chamber, in pressing upon the cornea with a blunt instrument, while a sponge was held on the wound. Pupillary membrane. S $\frac{0}{200}$. Discission. S $\frac{20}{100}$. I am particular in removing blood from the anterior chamber. It makes the subsequent steps of the operation uncertain, thus giving rise to accidents.

3. In 3 cases the *capsule was opened by the knife* on its passage through the anterior chamber. All did well.—As this opening is commonly insufficient, it should be enlarged with the cystotome after the iridectomy.

4. In case 108, a small *part of the anterior lip of the wound* was cut away in cutting the iris. The wound united slowly, and there was partial infiltration of the cornea. Though the result was good, the reaction showed that the accident was not indifferent, and that we should be careful to avoid it.

5. In case 32, a good deal *of rubbing of the lids over the cornea*, in order to remove remaining cortex, led to purulent infiltration of the edge of the flap. A moderate degree of rubbing is commonly done without bad consequences, and is certainly less injurious than to try to remove the remnants with a Daviel's spoon.—Result good.

6. Case 114. *Degenerated iris drawn out piecemeal and cut off.* Cataracta accreta. Trachomatous pannus. S $\frac{25}{200}$. Operative result excellent.—It is known that a cornea suffering from pannus has little tendency to slough.

7. In 3 cases—55, 82, 101—a *part of the iris, bordering on the coloboma, was pushed out of the wound by the passing lens, and evidently bruised.* Violent iritis followed in each case. In one (82), S=0; in the other (55) S $\frac{1}{\infty}$, later $\frac{5}{200}$; in the third S $\frac{12}{200}$, raised by an early iridectomy to $\frac{20}{70}$.—I make it a rule in such cases to extend the iridectomy, after the exit of the lens, so as to remove the bruised part of iris.

8. In 4 cases—19, 120, 128, 158—the lens was extracted with *a sharp hook.* In all of them *prolapse of vitreous* occurred. In

two there was no reaction, in the other two the reaction was moderate. S good in 3 cases; moderate in 1.

9. In 6 cases—1, 17, 34, 49, 103, 109—the lens was extracted with *a large spoon.* In one—103—it was done without loss of vitreous, in the other five vitreous escaped. In one—109—there was only slight irritation; S $\frac{20}{70}$. In the second—17—the union of the wound was tardy; S $\frac{20}{70}$. In the third—103—hyalitis set in on the 5th day, getting well, with S $\frac{20}{100}$. In the fourth and fifth—1, 49—destructive irido-cyclitis ensued; S $\frac{1}{\infty}$, S 0. In the sixth—34—the union of the wound was very slow, a bead of vitreous held the wound gaping for 6 weeks. It was touched with nitrate of silver 6 times without much reaction. On the seventh touching, purulent hyalitis set in, followed by phthisis bulbi. Occasional clipping of the prolapsed vitreous with the the scissors, and persistent bandaging seem to be the proper treatment of such cases.

Half the cases, in which a large spoon was used, were lost. In former years I made similar experience. I, therefore, employ the spoon only as a last resort.

10. In 4 cases—6, 125, 145, 146—the *section was too small*, making the further steps of the operation difficult and impure. In No. 6 considerable rubbing had to be done to remove the tenacious cortex. Ring-abscess and panophthalmitis followed. In Nos. 145 and 146, the smallness of the section made the expulsion of the lenses difficult and unclean, cortical matter remaining behind. Panophthalmitis in both. In case 125 fluid vitreous escaped immediately after the small section; the lens was drawn out with a sharp hook, some cortex remaining. Panophthalmitis. These four cases exemplify the injurious effect of an insufficient section in its worst light, but there are many cases in which comparatively little and even no damage is done to an eye by a small section. A healthy eye bears an incredible amount of injury, witness the great number of traumatic cataracts, where small, irregular, and often lacerated wounds of the cornea with prolapsed iris lead to absorption of the lens with astonishingly slight reaction. But cataractous eyes are not healthy eyes, they bear less injury, and, therefore,

the surgeon's constant endeavor should be to extract the lens with as little injury as possible, and since experience shows that an insufficient section entails a multitude of dangerous conditions, it is one of the greatest, if not the greatest, fault an operator for cataract could commit.

11. 9 cases (3, 21, 24, 42, 53, 85, 99, 100, 150, 164) were noted in which more or less *cortical substance remained in the eye.* Two of them (164 and 21) were lost by purulent iritis and keratitis. The others showed more or less intense reaction, but recovered good sight, except a case of zonular cataract (85), in which irido-capsulitis produced dense false membranes which, after an iridectomy, yielded only S $\frac{2}{200}$.

12. *Prolapse of vitreous* was the only or gravest accident in 16 cases (28, 50, 63, 115, 124, 131, 136, 141, 161, 162, 169, 172, 173, 175, 178, 190). In 7 there was no reaction, and sight was excellent. In 3 cases floating opacities, with good vision, were noted. In 1 case iritis and a pupillary membrane gave vision only $\frac{5}{200}$; in another, intense iritis was well cured with S $\frac{20}{100}$. In the remaining 4 cases suppuration in the vitreous ensued with loss of sight. Besides these 16 cases, there was loss of vitreous in 10 others where it was accessory to accidents mentioned before, such as extraction of the lens with a hook or spoon. There were, on the whole, 13% of the operations complicated with escape of vitreous. This, however, should not be mentioned as a drawback to Graefe's operation, nor does it argue personal carelessness or lack of skill, since prolapsus vitrei is almost an inherent incident to certain operative procedures, for instance, the extraction together with the capsule. If we deduct the cases (9 in number) in which the extraction with the capsule was originally decided upon and performed accordingly, only 8.5% should be mentioned as complicating Graefe's operation.

For the sake of a comprehensive review of the incidents of the operation and their consequences, I will put them in a tabular statement.

Nature of Accident.	*No. of Eyes.*	*Recovery:* *Smooth.*	*Recovery:* *Disturbed.*	*Result:* *Good.*	*Result:* *Moderate.*	*Result:* *Failure.*
1. Peripheric part of iris fell before knife and was cut off, ...	1		1			1
2. Copious hemorrhage after iridectomy	1		1	1		
3. Capsule opened by knife, . . .	3	2	1	3		
4. Part of anterior lip of wound cut away with iris scissors, ...	1		1	1		
5. Unusual degree of rubbing to expel cortex, ...	1		1	1		
6. Degenerated iris drawn out in pieces and cut off, ...	1		1		1	
7. Iris bruised by passing lens, . .	3		3	1	1	1
8. Lens extracted with sharp hook (prolapse of vitreous in all), ...	4	2	2	3	1	
9. Lens extracted with large spoon (loss of vitreous in 5), ...	6		6	3		3
10. Sec. too small (loss of vitreous in 1),	4		4			4
11. Cortical substance left in eye, . .	9	1	8	5	2	2
12. Escape of vitreous (not mentioned previously), ...	16	7	9	11	1	4
TOTAL,	50	12	38	29	6	15

The study of the

REACTIVE PROCESSES

which follow the extraction of cataract are of particular importance, and I may, therefore, be allowed to describe them more in detail than I did in my former reports. In the following tabular statement I have put together, in sixteen groups, all the anomalous features in the course of healing that had been noted in the cataract journal. I have not mentioned such as are of normal or almost normal occurrence, and do not influence the result, such as the ordinary striped keratitis, slight circumcorneal injection from hyperæmia of the iris leaving no synechiæ, nor the non-inflammatory thin obstructions of the pupil dependent on imperfect removal and wrinkling of the capsule, nor injection and swelling of the conjunctiva, if it occurred in an eye otherwise recovering without disturbance.

The *anomalous reactive processes, their relative frequency, and the visual results* which they yielded, may be seen in the following table.

Nature of Reactive Processes.	*Frequency.*	*Results :*		
		Good.	*Moderate.*	*Failure.*
I. Tardy closure of wound,	7	6		1
II. Reopening of wound,	4	4		
III. After-hemorrhage into the anterior chamber,	6	6		
IV. Cystoid scar,	3	1	2	
V. Incarceration of iris,	4	4		
VI. Deep-seated keratitis,	1	1		
VII. Simple iritis,	21	17	2	2
VIII. Spongy iritis,	5	5		
IX. Simple capsulitis,	5	4	1	
X. Simple hyalitis,	6	5	1	
XI Cyclitis and irido-cyclitis,	5	1	1	3
XII. Partial suppurative keratitis	6	5		1
XIII. Total suppurative keratitis	4			4
XIV. Purulent iritis,	8	1	1	6
XV. Purulent capsulitis and capsulo-iritis,	2	1		1
XVI. Suppurative hyalitis,	5			5
TOTAL,	92	61	8	23

The sum total shows that almost half the cases (46%), were followed by some reactive process or other. Many of them were insignificant, and did not materially interfere with a good recovery. I have arranged the different groups in such a way that the severer forms follow the milder, the severest—the suppurative inflammation—occupying the last place. The table may give some estimate of the relative danger connected with the different reactive processes, and on that account be of use to the practitioner in framing the prognosis, and directing the treatment of the reactive processes here described. The visual result does not, however, solely depend on the nature of the reactive processes, but on the quality of the cataract, the incidents of the primary and the success of the after-operations. The dependence of these conditions upon one another, and a short description of the disturbances of the healing process in each case, arranged according to the groups in the preceding table, will be found in the following tabular statement, which is intended to afford easy reference and facilitate the study of the reactive processes following Graefe's extraction, for which reason some repetition will, I trust, be pardoned. The numbers in the second column refer to the general table, where more information may be found, if desired.

Consecutive Numbers.	No. of Case in General Table.	Nature of Reactive Processes.	Quality of Cataract.	Incidents of Operation.	Primary Result. S.	After-Operations.	Final Result. S.
		I. Tardy Closure of Wound.					
1	17	No irritation.	Hypermature. Thickened capsule.	Extraction with spoon. 1 or 2 drops of vitreous.	$\frac{20}{100}$		
2	34	Part of wound held open by a small bead of clear vitreous. From 12th to 36th day 7 times touched with nitrate of silver; six times it produced no irritation, the seventh was followed by suppurative hyalitis.	Complicated.	Escape of fluid vitreous. Spoon.	$\frac{20}{70}$		0
3	111	No irritation.	Hard, ripe.		$\frac{20}{100}$		
4	113	Inner corner of wound bulging after violent fit of coughing.	Ripe.		$\frac{20}{50}$		
5	115	Wound closed on 3d day, reopened on 4th, closed on 6th. Floating opacities in vitreous.	Half-soft	Extr. with capsule. Escape of vitreous.	$\frac{20}{100}$		
6	167	No irritation.	Hard, ripe.		$\frac{20}{40}$		$\frac{20}{20}$
7	190	Very tardy closure, by intrusion into the wound of transparent vitreous which was repeatedly cut.	Complicated.	Escape of vitreous.	$\frac{20}{200}$		$\frac{20}{70}$
		II. Reopening of Wound.					
1	3	*Hurt* eye on 11th day, wound ruptured, closed again in 2 days without irritation.	Hard, ripe.	Cortex and blood remained.	$\frac{10}{200}$		$\frac{20}{40}$

Consecutive Numbers.	*No. of Case in General Table.*	*Nature of Reactive Processes.*	*Quality of Cataract.*	*Incidents of Operation.*	*Primary Result. S.*	*After-Operations.*	*Final Result. S.*
2	5	*Spontaneous* reopening on 3d day, closed again the following night.	Hyper-mature.		$\frac{20}{70}$		
3	42	*Traumatic* rupture of wound on 7th day, followed by escape of vitreous, but no bad consequences.	Complicated.	Some cortex left.	$\frac{20}{100}$		$\frac{20}{70}$
4	130	*Hurt* eye violently on 6th day, rupture of wound; hemorrhage into anterior chamber, gradually absorbed. Synechiæ and pupillary membrane.	Hard, ripe.		$\frac{8}{20}$	Discission.	$\frac{20}{100}$
		III. After-Hemorrhage into the Anterior Chamber.					
1	13	Pat. hurt his eye, on 3d day, while bandage was changed, hemorrhage into anterior chamber, disappeared in a few days.	Hard, ripe.		$\frac{20}{50}$		
2	31	Hem. on 4th day; absorbed in six days.	Hard, ripe.		$\frac{20}{40}$		
3	35	Hem. on 5th day. Absorption. Irido-cyclitis $4\frac{1}{2}$ years later.	Hyper-mature.		$\frac{20}{70}$	Division of wrinkled capsule, 18 months.	
4	110	Hem. on 4th day, absorbed in 3 days.	Hard, ripe.		$\frac{20}{70}$		
5 6	139 140	Hem. in both eyes; followed in right by thin pupillary membrane.	Hard, ripe, both.		$\frac{20}{200}$ $\frac{20}{100}$		$\frac{20}{100}$ $\frac{20}{40}$
		IV. Cystoid Scar.					
1	14	Cystoid scar in innner corner of wound, causing no irritation.	Immature.	Capsule opened with knife.	$\frac{20}{200}$	Discission.	$\frac{20}{40}$
2 3	39 40	Slow healing, cystoid protrusion of scar, synechiæ, pupillary obstruction in both eyes of an old negress.	Hyper-mature (both).		$\frac{6}{200}$ $\frac{15}{200}$		

Consecutive Numbers.	*No. of Case in General Table.*	*Nature of Reactive Processes.*	*Quality of Cataract.*	*Incidents of Operation.*	*Primary Result. S.*	*After-Operations.*	*Final Results. S.*
		V. Incarceration of Iris.					
1	93	Iris imprisoned in one corner of wound, causing no annoyance.	R. Hypermature. L. Hard, ripe.		$\frac{20}{70}$	Division of sec. cataract $3\frac{1}{2}$ years later.	$\frac{20}{50}$
2	94				$\frac{20}{20}$		$\frac{20}{40}$
3	133	Imprisoned prolapse of iris in one corner of wound, causing irritation of iris, was cut off on 5th day. Rapid recovery.	Hypermature.		$\frac{20}{20}$		
4	134	Small incarceration, causing acute suppurative iritis 18 months after operation. Eye saved by immediate removal of imprisoned iris.	Hard, ripe.		$\frac{20}{20}$	Removal of prolapse.	$\frac{20}{40}$
		VI. Deep-seated Keratitis.					
1	53	The posterior layers of the upper and centra- parts were opaque. Possible cause scraping with cystotome.	Hard.	Blood and cortex left.	$\frac{20}{200}$		$\frac{20}{70}$
		VII. Simple (plastic) Iritis.					
1	58	Leaving dense pupillary membrane.	Hard, ripe.		$\frac{10}{200}$	Iridectomy.	$\frac{20}{100}$
2	59	Pupillary membrane. (Prospects of secondary operation very good).	Hard, ripe.		$\frac{10}{200}$		
3	60	Dense pupillary membrane.	Hard, ripe.		$\frac{2}{200}$	Division.	$\frac{20}{70}$
4	63	Pupillary membrane.	Hard, ripe.	Escape of vitreous.	$\frac{5}{200}$	Triangular iridotomy with scissors. Panophthalmitis.	0

Consecutive Numbers.	*No. of Case in General Table.*	*Nature of Reactive Processes.*	*Quality of Cataract.*	*Incidents of Operation.*	*Primary Result. S.*	*After-Operations.*	*Final Result. S.*
5	74	Closure of pupil.	Hard, ripe.		$\frac{1}{\infty}$ F. + complete.		
6	84	Pupillary membrane.	Complicated.		$\frac{15}{200}$	Division.	$\frac{20}{50}$
7	99	Some synechiæ.	Hard, ripe.	Some cortex left.	$\frac{20}{70}$		$\frac{20}{40}$
8 9	117 118	Pupillary obstructions in both.	Hyper mature (both).		$\frac{5}{200}$ $\frac{10}{200}$	Division (both).	$\frac{5}{200}$ $\frac{15}{200}$
10	129	Mild iritis. No sequels.	Morgagnian.		$\frac{20}{20}$		
11	134	Closure of pupil.	Hard, ripe.		$\frac{2}{200}$	Iridectomy.	$\frac{20}{50}$
12	141	Mild.	Hard, ripe.	A few drops of vitreous.	$\frac{16}{200}$		$\frac{20}{100}$
13	147	Closure of pupil.	Hard, ripe.		$\frac{1}{\infty}$	Iridectomy.	$\frac{20}{50}$
14	150	Mild iritis.	Half-soft		$\frac{20}{50}$		
15	158	Mild iritis.	Immature.		$\frac{20}{70}$		
16	161	Intense iritis.	Hypermature.		$\frac{20}{70}$		
17	168	Mild.	Hard, ripe.		$\frac{20}{50}$		$\frac{20}{30}$
18	171	Mild.	Hypermature.		$\frac{20}{200}$		$\frac{20}{50}$
19	180	Mild. Thin pupillary membrane.	Hard, ripe.		$\frac{20}{70}$		
20	188	Mild.	Hard, ripe.		$\frac{20}{100}$		
21	189	Iritis. Set in a week after extraction.	Hard, ripe.		$\frac{20}{70}$	Division.	$\frac{20}{70}$

Consecutive Numbers.	No. of Case in General Table.	Nature of Reactive Processes.	Quality of Cataract.	Incidents of Operation.	Primary Result. S.	After-Operations.	Final Result. S.
		VIII. Spongy Iritis.					
1	20	Spongy exudation on 3d day, absorbed in 10 days.	Soft, ripe.		$\frac{20}{100}$		$\frac{20}{30}$
2	41	Spongy exudation ; Iritis ; slight synechiæ.	Hard, ripe.		$\frac{20}{200}$		$\frac{20}{50}$
3	73	Spongy exudation. Absorption leaving some capsular opacities. Three weeks after his discharge capsulitis with hypopyon. Recovery.	Hard, ripe.		$\frac{20}{200}$		$\frac{20}{100}$
4	100	Marked spongy exudation. Absorption began on the 5th day ; pupillary membrane.	Immature.	Cortex & tough capsule remain'd	$\frac{10}{200}$	Crucial incision.	$\frac{20}{70}$
5	105	Spongy ex. on 4th day, lasting 5 days.	Half-soft		$\frac{20}{200}$		
		IX. Simple and Plastic Capsulitis.					
1	23	Plastic capsulitis. Blood in pupil. Pupil large.	Hard, ripe.		$\frac{10}{200}$		Prospect good.
2	69	Plastic capsulitis, travelling around edges of coloboma, leaving centre of pupil free.	Hard, ripe.		$\frac{20}{200}$		$\frac{20}{20}$
3	116	Plastic irido-capsulitis ; pupillary membrane.	Hard, ripe.		$\frac{20}{100}$	Division.	$\frac{20}{40}$
4	120	Plastic capsulitis ; pupillary membrane.	Hypermature.	Removal of part of anterior, laceration of posterior capsule.	$\frac{5}{200}$	Iridectomy.	$\frac{10}{200}$
5	126	Irido-capsulitis ; pupillary membrane.	Hard, ripe.	Unusual hemorrhage after iridectomy.	$\frac{10}{200}$	Division.	$\frac{20}{100}$

Consecutive Numbers.	*No. of Case in General Table.*	*Nature of Reactive Processes.*	*Quality of Cataract.*	*Incidents of Operation.*	*Primary Result. S.*	*After Operations.*	*Final Result. S.*
		X. Simple Hyalitis.					
1	105	Opacity of vitreous, first visible on 5th day; slow, but good recovery.	Hypermature.	Extraction with large spoon; no escape of vitreous.	$\frac{20}{100}$		
2	119	Diffuse opacity of vitreous. Perfect recovery.	Soft.	Extraction with capsule.	$\frac{20}{30}$		
3	124	Diffuse and formed (floating) opacities in vitreous. Recovery from inflammatory symptoms in 30 days.	Hypermature.	Extr. with capsule.	$\frac{20}{200}$		
4	148	Opacities in vitreous distinct on 5th day. Iritis subsequently. Pupillary obstruction.	Complicated.	Extr. with capsule. No instrument introduc'd. No escape of vitreous.	$\frac{5}{200}$		
5	157	Mild, but very obstinate (34 days) irido-hyalitis.	Hard, ripe.		$\frac{20}{100}$		$\frac{20}{30}$
6	178	Floating opacities in vitreous when discharged.	Ripe.	Escape of a few drops of vitreous.	$\frac{20}{50}$		
		XI. Cyclitis and Irido-cyclitis.					
1	1	Very painful hyalitis and irido-cyclitis. From 5th to 10th day +T1; after six weeks eye quiet. −T1.	Hard, ripe.	Escape of vitreous. Extraction with large spoon.	$\frac{1}{\infty}$		$\frac{1}{\infty}$
2	49	Cyclitis. 4th day: yellowish reflex from well-dilated pupil. 10th day ·	Immature.	Knife blunt; escape of	$\frac{1}{\infty}$		0

Consecutive Numbers.	No. of Case in General Table.	Nature of Reactive Processes.	Quality of Cataract.	Incidents of Operation.	Primary Result. S.	After-Operations.	Final Result. S.
		synechiæ. 16th day hemorrhage into anterior chamber; 19th day: hemorrhage repeated, iris bulging. 39th day: eye shrunken.		vitreous. Extrac. with large spoon.			
3	85	Recurrent capsulitis and irido-cyclitis. Iris uneven. Dense secondary cataract.	Zonular cataract in person 43 yrs. old.	Transparent cortex left.	$\frac{1}{200}$	Iridectomy.	$\frac{2}{200}$
4	166	Irido-cyclitis. Closure of pupil. Indrawn scar.	Morgagnian.		$\frac{1}{\infty}$		
5	187	Irido-cyclitis. Iris in one place considerably bulging. Centre of pupil remained clear. Bulging disappeared.	Hard, ripe.		$\frac{20}{100}$		$\frac{20}{50}$
		XII. Partial Suppurative Keratitis.					
1	21	Purulent infiltration of corneal edge of wound. Slow iritis. Closure of pupil.	Hard, ripe.	Cortex left.	$\frac{1}{\infty}$		
2	32	Partial suppurative keratitis. Iritis.	Hard, ripe.	A good deal of rubbing.	$\frac{20}{200}$		$\frac{20}{70}$
3	33	Severe partial suppurative keratitis. Absorption. Iritis. Dense pupillary membrane.	Hard, ripe.		$\frac{6}{200}$	Iridectomy.	$\frac{20}{40}$
4	61	Purulent infiltration of cornea in both corners of wound. Iritis. Pupillary membrane.	Hard, ripe.		$\frac{1}{200}$	Division.	$\frac{20}{100}$
5	101	Partial kerato-iritis. Tongue-like plug of pus descended from inner corner of wound into anterior chamber. Inflammation 35 days. Dense pupillary membrane.	Half-soft	A small piece of iris, caught in inner corner of wound, cut off.	$\frac{12}{200}$	Iridotomy (on 30th day).	$\frac{20}{70}$

Consecutive Numbers.	No. of Case in General Table.	Nature of Reactive Processes.	Quality of Cataract.	Incidents of Operation.	Primary Result. S.	After-Operations.	Final Result. S.
6	108	Part. suppur. keratitis, mild. Slow closure of wound.	Half-soft	Part of edge of flap cut with scissors.	$\frac{20}{70}$		
		XIII. Total Suppurative Keratitis.					
1	6	*Ring-abscess.* Panophthalmitis. Phthisis bulb.	Hard, ripe.	Section small. Considerable rubbing to expel cortex.	0		
2	9	Suppuration of cornea beginning at inner corner of wound. Flat leucoma (phthisis anterior).	Hard, ripe.		0		
3	37	Suppuration began at edges of wound 2d day; *ring-abscess* 3d day; panophthalmitis. (The other eye operated on 15 months previously. Recovery and vision good.)	Hard, ripe. (General health good).	(A very smooth Graefe's operation. Immediate visual result excellent.	0		
4	87	Suppuration of cornea beginning in corners of wound. Panophthalmitis.	Hyper-mature. (Patient æt. 79, decrepit).	(Peripheric regular section).	0		
		XIV. Purulent Iritis.					
1	55	Violent iritis; plug in pupil; hypopyon. Dense pupillary membrane.	Hard, ripe.	Inner border of iris pushed out by passing lens.	$\frac{1}{\infty}$		$\frac{5}{200}$
2	80	Purulent iritis. Panophthalmitis.	Hard, ripe.		0		

Consecutive Numbers.	*No. of Case in General Table.*	*Nature of Reactive Processes.*	*Quality of Cataract.*	*Incidents of Operations.*	*Primary Result. S.*	*After-Operations.*	*Final Result. S.*
3	82	Purulent iritis, starting from inner border of coloboma. Panophthalmitis.	Hypermature.	Inner border of iris pushed into wound & bruised by passing lens.	0		
4 5	145 146	Purulent irido-keratitis and panophthalmitis in both.	Hypermature (both).	Section small, expulsion difficult. Cortex left behind, in both eyes	0 0		
6	154	Purulent iritis. Complete closure of pupil.	Ripe, large.	Small peripheric part of iris bruised and cut by cataract knife	$\frac{1}{\infty}$		$\frac{1}{\infty}$
7	164	Purulent iritis.	Immature.	Expulsion difficult. Cortex left.	$\frac{1}{\infty}$		
8	193	On 3d day: iritis; 5th day: pus in pupil and anterior chamber; 6th day: infiltration of part of flap. Gradual absorption.	Hard, ripe.		$\frac{1}{\infty}$		$\frac{20}{200}$
		XV. Purulent Capsulitis and Capsulo-iritis.					
1	44	Suppurative and hemorrhagic capsulitis, beginning at upper edge of capsule travelling all around. Repeated hemorrhages. Hypopyon. Closure of pupil. Tn.	Hard, ripe.	A quadrangular piece of capsule cut out, as usual.	$\frac{1}{\infty}$		

Consecutive Numbers.	*No. of Case in General Table.*	*Nature of Reactive Processes.*	*Quality of Cataract.*	*Incidents of Operations.*	*Primary Result. S.*	*After-Operations.*	*Final Result. S.*
2	198	Capsulo-iritis, purulent and hemorrhagic. Gradual absorption. Dense pupillary membrane.	Hard, ripe.		$\frac{1}{\infty}$	Iridectomy.	$\frac{20}{200}$
		XVI. Suppurative Hyalitis.					
1	125	On 3d day suppuration in vitreous. Panophthalmitis. Atrophy of globe.	Complicated.	Extraction with hook. Considerable loss of vitreous.	0		
2	131	Suppurative hyalitis and iritis. Pupil closed. F complete.	Cystic, of 40 y'rs duration.	Extraction with capsule, without introduction of instruments.	$\frac{1}{\infty}$		
3	172	Suppuration in vitreous. Great pain. Indrawn scar.	Complicated.	Escape of vitreous.	$\frac{1}{\infty}$		
4	173	Suppuration in vitreous. Pupil closed.	Complicated.	Escape of vitreous.	$\frac{1}{\infty}$		
5	175	Suppuration in vitreous. Pupil closed by yellow substance.	Complicated.	Escape of vitreous.	0		

The foregoing table may suggest many reflections, but as it speaks for itself, I shall content myself with the following:

I. Of the seven cases in which a *slow union of the wound* is noted, four were distinguished by escape of vitreous during the operation. The best mode of treatment seems to be to keep the eye closed by a compressive bandage until the union is effected. In case conjunctival irritation forbids the permanent closure of the lids, the bandage may be removed for several hours during the day, or during the night, and reapplied in the morning.

If vitreous protrudes through the wound, either as a transparent or a whitish mucoid substance, it seems best to cut it off with a pair of scissors, in order to remove from the wound the foreign substance which keeps it gaping, and when protruding exerts, during the movements of the eye, a certain degree of injurious traction. Touching the prolapse of vitreous or the ununited part of the wound with caustics seems highly objectionable, a fact emphatically illustrated by case 34.

All the cases, except the one just mentioned, recovered. That in many cases of slow closure of the wound—three to six or more days—no reaction follows is well known, yet I consider such a condition not only as anomalous, but as decidedly less favorable than the closure in the first or second night, and cannot in this point agree with Prof. *O. Becker*,* who thinks "that the delayed restoration of the anterior chamber is almost a favorable condition as to the final result." If the section closes soon after the operation, the wounded internal parts are protected from all external prejudicial influences, and the recovery under such conditions seems to me a great deal easier than with an open wound, just as an uncomplicated fracture presents a better prognosis than one that is complicated. Though I think that the dangers from the *infectious* qualities of the atmosphere and the conjunctival secretion have of late been very much exaggerated, I believe that foreign substances of any kind act injuriously on all wounds of the eyeball, since in

* Pathologie u. Therapie des Linsensystems, in *Graefe-Saemisch's Cyclopedia*. Vol. v., p. 361.

the eye, healing by first intention is almost indispensable for a good recovery.

According to these views I conduct the after-treatment. The patient is kept as quiet as possible, until the wound is permanently closed. During the first day or two no visitors, no conversations, no reading to him, no physical exertion are allowed. If he is restless, anodynes are administered. If I discover a low tendency of the wound to unite, by finding either the lint wetted or a stream of "tears" (aqueous humor) running from the eye when the bandage is changed and the eye cleansed, I do not open the lids—unless in addition there be pain or œdema and discharge. I sometimes keep the bandage unchanged for 24, 36 or 48 hours. Under these circumstances, I think that a limited rehabilitation of the old custom of a permanent bandage after the operation is good practice.

II. The *reopening of the wound* was notoriously the result of a hurt in three cases out of the four which are noted in the book. I have always been of opinion that the sudden and unexpected evacuation of the anterior chamber after the third day, in a regular course of healing, was mostly the result of an injury. The patient strikes his eye against a pillow, or unconsciously rubs it in his sleep. To prevent such an accident, I, in common with others, take the precaution of loosely tying the hands of the patient during the night, whenever he is restless, or complains of itching in his eye. The rupture of the wound, in an otherwise favorable case, is not a serious complication.

III. *After-hemorrhage into the anterior chamber* was noted in six cases (3%), all of which did well. I do not know what, in some cases, produces this after-hemorrhage, nor does the same occurrence after operations on other parts of the body throw any light on the subject. If we speak of a peculiar predisposition, it should be defined, and, if possible, pointed out before the operation. I would then make the section less peripheric, to avoid vascularized tissue. We all consider a perfect dilatability of the pupil by atropine as a favorable condition. If the dilatation is effected by the contraction of the muscular coats of the

blood-vessels, an eye whose pupil is imperfectly dilated by atropine suffers from atrophy or paralysis of this muscular coat; and a certain degree of passive congestion must be present. That such eyes are more than others predisposed to inflammatory reaction, in particular to purulent iritis, seems generally admitted, and I have seen it illustrated by many examples in my own experience. But I shall, in future, direct my attention particularly to the question whether such eyes are or are not more predisposed than others to primary (during the operation) and secondary hemorrhages.

IV. *Cystoid scar* was noted in 3 cases ($1\frac{1}{2}\%$) only. The one was an immature (swollen) cataract, in a woman of 42 years of age, the other two were hypermature cataracts in an old negress. I know nothing about the conditions that lead to the formation of a cystoid scar. There was no symptom of glaucoma in any one of the three eyes so affected.

V. *Incarceration of iris in the scar* is mentioned in four cases (2%), but occurred more frequently. In two cases only it caused irritation, in the one soon after the extraction, in the other 18 months later. I think it is good practice to remove the imprisoned iris whenever symptoms of irritation manifest themselves, as in case 133. The other case (134) in which purulent iritis set in has been above fully discussed.

VI. *Plastic iritis*—21 cases, $10\frac{1}{2}\%$—is the most frequent morbid process after extraction. It led in two cases to complete closure of the pupil with preservation of the shape and tension of the globe, and good perception of light. In the one case (147) iridectomy yielded a perfect result (S $\frac{20}{50}$), in the other (74) iridectomy offered the same chances, but the patient did not reappear. In the great majority of these cases a judicious after-operation will not fail to convert moderate into good results. In one of our cases (63), the eye which had S $\frac{5}{200}$, was destroyed by an iridotomy. The treatment of iritis was the ordinary antiphlogistic treatment of non-traumatic iritis, and proved, in general, very satisfactory. In these cases, careful observation of the eye soon after the operation, leading to the early discovery of iritis, saves many an eye.

VII. A peculiar form of iritis which, some time before the first cases were described, I demonstrated to my class, under the name of *spongy iritis* or *spongy exudation*, was noted in 5 cases ($2\frac{1}{2}\%$). This form is not peculiar to eyes operated on for cataract. I have seen it after operations for glaucoma, and in spontaneous, either syphilitic or non-syphilitic, iritis. *O. Becker* gives a—rather insufficient—description of it.* It is identical with the lens-like exudation of *H. Schmidt* † and the gelatinous exudation of *Dr. Gunning*.‡

Commonly on the third or fourth day after the operation œdematous swelling of the edge of the upper lid and lachrymal region with more or less chemosis sets in. There is moderate, sometimes intense pain. The secretion is watery, or sero-mucous, never purulent. The episcleral injection is marked. In the pupillary space appears a spongy-looking, semi-transparent substance of exceedingly fine, irregularly interlaced filaments, of grayish color, sometimes with a yellowish tinge. It increases during one or three days and may fill the anterior chamber either partially or totally. If it occupies the *whole anterior chamber*, it greatly diminishes the vision, sometimes to mere perception of light, the pupil is clouded and the iris very dull—apparently infiltrated, in reality, however, only covered—and this dullness may be mistaken for diffuse opacity of the cornea. On the third, fourth, or fifth day, the irritative symptoms suddenly disappear, the pain ceases, the swollen conjunctiva collapses, and a process of contraction seems to take place in the exudation. The grayish substance shows sharp edges, around which the periphery of the iris is seen in its normal lustre, and the mass itself looks like a compact, grayish, semi-transparent body, resembling a crystalline lens, dislocated into the anterior chamber, and for such it has, in cases of spontaneous spongy iritis, been mistaken. From day to day the grayish

* L. c., p. 358, lines 4 to 22.

† Zeh. Klin. Monatsbl. f. Augenhl. 1871, p. 96.

‡ Zeh. Klin. Mon. 1872, p. 7. See also: *E. Grüning:* Spongy Exudation. These ARCH. III. p. 20. *C. J. Kipp:* Syphilitic Iritis with Gelatinous Exudation. These ARCH. III. p. 71.

compact mass becomes smaller, a part of the pupil, and at last the whole pupil, becomes free and clear. This process of absorption may last from three to ten days.

The cases where the exudation fills only *a part* of the anterior chamber are more frequent, but less characteristic. The area of the pupil and its immediate surroundings are occupied by a grayish substance, which in the first day or two has a spongy appearance, then becomes compact, and shows the same sharp edges as the larger masses. By its contraction and absorption, first a part of the pupil becomes free and black, and gradually the whole pupil is disengaged and clear. The irritative symptoms are less severe than in the forms in which the whole anterior chamber is filled.

In *spontaneous* spongy iritis the exudation may also fill the anterior chamber either partially or totally. The exudation begins commonly at the lower part of the iris, and may, when the pupil is dilated with atropine, be characteristic from the outset. The lower part of the anterior chamber is hazy, gray, frequently with a yellowish tinge, and the lower part of the pupil is occupied by an irregular network of coarser filaments which by oblique light and a large lens may be distinctly seen through the diffuse, semi-transparent, not yet contracted exudation in the anterior chamber. The haziness increases in extent and density, and in two or three days, may fill the whole anterior chamber. Then contraction takes place, the edges become sharp, withdraw from the periphery of the chamber, and the globular, gelatinous mass is very characteristic. If absorption begins before the whole anterior chamber is filled, the edges of the exudation are mostly less sharp, yet the disease may be diagnosticated by the comparative clearness of the upper part of the chamber. The upper part of the pupil appears like a black crescent, while the remainder is occupied by the grayish substance. Total absorption took place in all cases that came under my observation.

I have notes of about 18 cases of spongy exudation, which might serve to draw a sufficiently clear clinical picture of this peculiar form of iritis. There are, of course, transitional forms

in which the differential diagnosis offers some difficulty. They border, on the one side, on the ordinary plastic iritis, on the other, on the purulent iritis. The *pure* forms of spongy exudation are distinguished by the absence both of plastic pupillary excrescences and of pus (hypopyon). Immediately after the absorption of the hyaline, grayish substance, the pupil is widely dilated, free from adhesions, and the iris shows no structural changes. The recovery is rapid and complete. The transitional forms are, however, complicated with synechiæ and pupillary obstructions. The spongy exudation, in such cases, may be considered as an additional though peculiar feature of plastic iritis or irido-capsulitis. In some intense cases of spongy iritis, I have for a day or two been in doubt whether purulent iritis would develop or not. Though the yellowish tinge of the lowest part of the exudation looked suspicious of pus, yet it could be distinguished from hypopyon by its diffuse nature; the border-lines were always gradually fading away, and never assumed the sharp outlines, nor had its centre the uniform saturated white color by which hypopyon is so distinguished.

I have seen spongy iritis, traumatic and spontaneous, complicated with venous hyperæmia of the retina, diffuse opacity of the vitreous, and grayish circumscribed exudations in the fundus, the form of which was oval with a longest diameter reaching two P DD. in length. They occupied the bottom of the vitreous chamber and covered the details of the fundus. This condition leads me to believe that they are compact exudations at the bottom of the vitreous, like those in the anterior chamber, though they greatly resemble circumscribed choroidal exudations, so much the more because the choroidal exudations in the initial stage are also surrounded by diffuse opacity of the vitreous. The complication with choroiditis and cyclitis is mentioned also by Schmidt and Gunning.

The anatomical nature of spongy exudation is a *fibrinous deposit*. Dr. *A. Alt** has examined and described one specimen taken from my collection, and in another case I extracted the exudation from a living eye, and placed it immediately under

* Anatomical Contributions, No. XII. These ARCHIVES. Next number.

the microscope. It consisted of a dense network of very delicate fibrils, enclosing white and red blood corpuscles, and of a finely granular substance. The case was that of a woman, on whose eye I had performed an iridectomy for glaucoma. The day after the operation the greater part of the anterior chamber was filled with a grayish, compact substance with sharp edges. This substance protruded through the wound, which was imperfectly closed. I seized the protruding part with a pair of iris forceps, and extracted it, together with a portion of the exudation which occupied the anterior chamber. This fibrinous nature explains the clinical features of the spongy exudation. In traumatic cases it is probably poured out from the cut edges of the coloboma, and when its quantity is limited it adheres to these edges and to the anterior capsule. After cataract extractions the shreds of the capsule may, perhaps, also furnish this kind of exudation. I have seen it in cases where the iris remained fairly normal and the pupil moderately dilated, whereas in the pupillary space the shreds of capsule were thickened, opaque, beset with whitish dots, and soon afterward a thicker, grayish, compact substance filled the pupillary space, projected into the anterior chamber, and overlapped the adjacent iris. During its contraction it assumed sharp edges, a small crescent of black pupil became visible, and at last, in from three to ten days, the whole mass was absorbed. It was impossible to mistake these grayish plugs for remnants of lens, since, one or several days after the removal of the cataract, the pupil was seen black, containing nothing but thin pieces of transparent capsule. The gradual development and increase of the spongy exudation could be watched, and offered the same features as in spontaneous spongy iritis. Its disappearance followed the same course.

From the different aspects which the spongy exudation presents, some conclusions as to its constituent parts may be derived. When the substance is uniformly semi-transparent (hyaline, gelatinous, like a dislocated lens), it probably consists exclusively, or almost exclusively, of coagulated fibrine ; if it has a grayish or whitish-gray color, the fibrine seems to contain a certain

amount of white blood corpuscles, which, when accumulated in clusters, will appear like whitish dots. The yellowish or yellow-greenish tinge indicates, in my opinion, the presence of red blood corpuscles. This argument, I think, is strengthened by the fact that I saw only the lowest part of the exudation greenish-yellow, which, it seems to me, is due to the gravitation of the red blood corpuscles.

The *prognosis* of spongy exudation, as far as my present experience goes, is favorable.

Its *treatment* is simple, and need not here be dwelt upon.

IX. *Simple or plastic capsulitis figures in the table with* 5 *cases* ($2\frac{1}{2}$%), *and*—XV.—*purulent capsulitis with* 2 *cases* (1%).

The inflammatory processes which originate in the capsule, and either remain confined to it, or extend to the neighboring parts, if attentively watched, offer such distinctive features that the term capsulitis, as the inflammation of a special organ, is as applicable as that of iritis or keratitis. I have, in my former reports, dwelt more or less extensively on the clinical picture of this disease.

The history of the two hundred extractions now under consideration has added new material to complete the picture. The irritative processes, due to the incarceration of the capsule in the wound, have of late years been more closely studied, both clinically and microscopically (*A. Pagenstecher*, *O. Becker*, *Iwanoff*, *Von Wecker*, and others). The pupillary opacities which result from remnants of cataract, iritis, and chronic thickening of the capsule have, under the name of secondary cataract, been described over and over again, but the clinical picture of primary acute traumatic capsulitis seems not to have received the attention it deserves. The method of exsecting a quadrangular piece of the anterior capsule, which I have practised for many years, rendered observations on pure capsulitis particularly fruitful.

In typical cases the picture is the following. In a ripe, uncomplicated cataract, a square-shaped piece of capsule is circumcised with a sharp sickle-shaped cystotome, and removed either with the cystotome, or a delicate pair of forceps. In many

cases it comes out with the cataract. Repeatedly have I been able to find this piece of capsule, and identify it under the microscope. When I did not find it, I could, in many cases, demonstrate its excision by focal illumination. Since, in most instances, I was scrupulously careful in removing the remnants of lens, a perfectly free pupillary space, bordered by sharp edges of a grayish, translucent membrane, like the frame of a picture, could with oblique light and a large magnifying glass be distinctly seen, sometimes immediately after the operation, but always one or several days later, leaving no doubt that the quadrangular free space was not the result of a retraction, but of a removal of so much capsule. One or several days after the extraction, when the pupil was dilated with atropine, and free from iritic adhesions and remnants of the lens, the edges of the capsule were evenly stretched across the eye, at an appreciable distance behind the iris. The upper edge presented a narrow strip which was neither applied to the cornea nor adherent to the closed wound. The majority of these cases showed no reaction and yielded excellent results.

In some, however, peçuliar changes took place in the capsule, and *in the capsule only*. Accompanied by moderate circumcorneal hyperæmia, one point of the edge (the frame) of the capsular window, commonly the inner-upper or outer-upper corner, grew opaque, gray or whitish. This opacity, in from two to four days, spread over the whole superior strip of capsule, cleared up at the corner from which it started, became more saturated and lingered for a few days at the opposite corner, then the whole superior strip cleared up, but the adjacent part of the vertical column of the capsule coloboma became opaque, and the opacity spread over the lateral edge in the same way as it had gone over the superior. While it cleared up, it extended over the lower edge, left this, and ascending, invaded the other lateral edge, which, in some days, also cleared up. While in this way the infiltration travelled all around the border of the capsule coloboma, the centre of the pupil, the aqueous and vitreous remained clear, the iris free from adhesion, and S continued

good. The duration of this process was from ten to fourteen days.

This picture of a simple, pure, uncomplicated capsulitis offers numerous variations. As has been said above, a kind of spongy exudation may be connected with it, obscuring the pupil for a while, then disappearing. The exudation, however, may also be diffuse, plastic, or purulent. Diffuse exudation renders the pupillary area and the whole anterior chamber turbid. The iris is hyperæmic, but the pupil is fully dilated, the circumcorneal injection and the pain are very moderate; absorption is followed by good sight. Plastic capsulitis is complicated with iritis. After a few days of irritation, the anatomical cause of which remains undetermined, a striated and irregularly opaque substance extends from the wound through the pupil, unites with the pupillary edge of the iris, contracts it, and draws the iris upward. I am speaking here of such cases in which the reaction originates in the capsule, and only secondarily involves the iris. The capsule, in such cases, is fastened in the wound, as may be demonstrated a day after the operation or later, and for a few days, this part of the capsule is the only one that becomes opaque and swollen. After a somewhat protracted course of from three to six weeks, the irritative symptoms disappear; a pupillary membrane is left; the vision is moderate, but becomes good by a simple horizontal or ⊥ shaped splitting of the membrane. Some degree of cyclitis seems to be connected with this kind of plastic capsulitis, for in a recent case in which I divided the pupillary membrane, about four weeks after the extraction, shreds of tissue could be seen behind it. Encouraged by *Wecker's* recent publications, I made this operation with a very sharp, broad needle, to prevent the iris from being drawn upward by the contracting pupillary membrane. The reaction was moderate and the result satisfactory.

Cases of *purulent capsulitis* I have seen frequently enough to distinguish its peculiar features. There is at first moderate circumcorneal injection, hyperæmia of the iris with a pupil dilatable by atropine. The pupil becomes hazy, and the capsule thickened and opaque. In cases where a part of the capsule

was removed, commonly one of the upper corners of the capsular coloboma first grows white, and then yellowish-white, bearing the greatest resemblance to a pustule. The surrounding capsule becomes opaque, and one or several other places, frequently the other upper corner, are the seat of other pustules. The centre of the pupil may remain tolerably clear, but hypopyon soon appears. If the capsule was irregularly divided, the pustules may appear in the centre or near the centre of the pupil, give rise to hypopyon, while the periphery of the pupil remains comparatively clear. It is by such cases (see my former reports), that I became convinced, I had to deal with a suppurative process of the capsule. There were no appreciable remnants of cataract, no visible changes in the vitreous, the iris was only moderately implicated—scant filiform adhesions—and the corneal section was perfectly closed and free from irritation. There was in these cases moderate pain, chemosis, œdema of the lids, and sero-mucous discharge. The suppuration may set in a week after the extraction or later, and I remember one instance where the patient had been discharged, at his urgent solicitation, though not fully cured, and returned a week later with a pustule in the centre of the pupil and hypopyon, pupil dilated, iris hyperæmic, and in some places adherent to the capsule; in less than a week the pustule and hypopyon had disappeared. The issue of these cases is mostly favorable; they require careful after-treatment (leeches, atropine, rest in bed, closure of the eyelids, darkness), but since severer complications on the part of the iris, ciliary body, and vitreous are absent, a more or less simple pupillary membrane is the only obstacle to good sight, and this obstacle can be easily removed.

X. *Simple Hyalitis* is mentioned in 6 cases (3%). Opacities of the vitreous are of very frequent occurrence after cataract operations, as we may convince ourselves by examining the eye with the ophthalmoscope during the first week after the extraction. They never fail, as far as my experience goes, after extractions with the capsule, whether these extractions are performed with or without the introduction of traction instruments; they are always present if the extraction is complicated

with prolapse of vitreous. The exudation in hyalitis may be diffuse, plastic (cords, flakes, and membranes), and purulent. In a majority of cases, especially after extractions with the capsule, they seem to be the result of hyperæmia and inflammation of the ciliary body. If the exudation remains diffuse (simple hyalitis), the issue is always good; if it is plastic, the recovery may linger and be imperfect, resulting in permanent floating opacities of the vitreous, with their prejudicial influences on the ciliary body, the substance of the vitreous, the hyaloid membrane—which may be detached—and the retina. They may, however, clear up after a duration of many months. I need hardly mention that hyalitis is frequently only a secondary affection, resulting from the lesions of the parts directly concerned in cataract operations.

All the cases of simple and plastic hyalitis noted in the table did well, one only (148) yielded a moderate visual result ($\frac{5}{200}$), offering, however, good prospects for an after-operation.

All the cases of XVI. *Suppurative Hyalitis* (5, or $2\frac{1}{2}$%), led to the loss of the eye. In every one of them the cataract was complicated, and the extraction followed by loss of vitreous. The suppuration began in the vitreous itself, the cornea and iris being only secondarily involved. Enough has been said on this subject by *Arlt*, *Becker*, and others.

XI. *Cyclitis and Irido-cyclitis* are mentioned in 5 cases ($2\frac{1}{2}$%), one of which only was a success, and this case (No. 187) was very remarkable. After a smooth operation of a hard ripe cataract in a middle-aged man, with clear and dilated pupil, there was very marked circumcorneal injection, and gradually the inner-upper part of the iris became bulging, as we see it in the so-called crater-shaped pupil. The centre of the pupil remaining clear, vision good, and the bulging limited to the inner part of the iris, I abstained from operative interference, and saw that the protrusion, in the third week of its existence, began to diminish, and finally disappeared altogether, leaving V $\frac{20}{50}$. This was evidently a case of partial cyclitis, that is, in one place there was a sacculated cyclitic exudation behind the iris; the pronounced general circumcorneal injection and the discolora-

tion of the whole iris indicated that the whole ciliary body participated in the inflammation.

The cases mentioned in the table show that cyclitis, after cataract operations, as cyclitis in general, is commonly a secondary affection, engendered by extension of the irritation to neighboring parts. It may, in its course and consequences, become more important than the primary disease. In its graver forms, the chronic, frequently relapsing cases of irido-cyclitis, it represents one of the most deleterious eye diseases, since it not only is the terminal affection in one eye, but endangers the other by sympathy. I would longer dwell on this subject, but the remarks which *O. Becker* makes on it in his repeatedly quoted treatise, and the references to his own original investigations, and those of *A. Pagenstecher*, *Iwanoff*, and others, are so instructive that I am afraid of making too many repetitions.

XII. *Partial Suppurative Keratitis*, observed in 6 cases (3%), has, it seems to me, mostly local causes—bruising of the edges of the wound by the turning of the knife, or the passage of a hard cataract, impaction in the section of iris, capsule and remnants of lens, a good deal of rubbing to remove the cortex, cutting the edge of the flap, etc. In some cases it is difficult to determine whether the suppuration originates in the cornea or the adjacent part of the iris. Partial suppurative keratitis has often been described, and many modes of treatment for it have been highly praised as having the effect of preventing the suppuration from becoming total. I have, for years, and especially in cases making part of those now under consideration, treated partial suppurative keratitis as a pustule, which I opened more or less freely, evacuating the anterior chamber at the same time. The results have been highly satisfactory. This treatment, I think, is rational and should not be abandoned. Yet it has failed me in cases which, for a while, looked as if the suppuration would remain limited, and in other similar cases I have seen equally good results from expectant treatment. In the virtues of the compressive bandage (Schnürverband) which *Von Graefe* so highly recommended, I never have had great faith, and if I am well informed, this faith, without any refutation, is

gradually weakening. The explanation of the success of all methods of treatment in certain cases of keratitis suppurativa, and of the failure of all in others, seems to me that certain local causes, as mentioned above, exert only a limited injurious influence, whereas in other cases the causes or conditions that lead to suppuration are so powerful that no medication can avert the disastrous termination. It is only in the cases touching on the borderline of these two groups, that treatment may save an eye, or if injudicious, help to destroy it.

XIII. There were four cases (2%) of *total suppurative keratitis* among the two hundred ; two of them showed the typical form of Graefe's "ring-abscess." The one case of "ring-abscess" (37) referred to a perfectly regular operation of a ripe cataract in a healthy person. Who can account for it? In the other case (6), smallness of the section and considerable rubbing to expel the cortex are noted. The next case (9) was again unexceptionable as to the conditions of patient and the operation, whereas in the fourth case (87), hypermaturity of the cataract, old age and decrepitude of the patient may be mentioned as predisposing causes. In opposition to Becker's statement* that "ring-abscess" does not seem to occur after Graefe's operation, the above cases convince me—and I am sure that in time every operator will share my conviction—that pure total suppurative keratitis is one of the disastrous issues of Graefe's operation, as well as of any other mode of extraction. The differences are only differences of frequency, not of kind, yet with regard to sloughing of the cornea, the linear methods have the advantage over the flaps.

XIV. *Purulent Iritis* was observed in 8 cases (4%). With the exception of one case (193), there was a direct cause of the suppuration mentioned ; bruising of the border of the iris with the knife or lens, expulsion difficult, considerable cortex left. Since all these incidents are well borne by the majority of cases, to understand the inordinate reaction in certain cases we have to inquire into the *degree* of bruising, the condition of the iris, and the *quality* of the remnants of cortex. If, on examining an eye

* Treatise in Graefe-Saemisch, p. 367, line 11.

before the operation, we are led to assume a greater vulnerability of the iris, we should be very particular in making a large corneal section and a very large coloboma. I mention this with special reference to eyes the pupils of which dilate only insufficiently by atropine, for I think such irides are more vulnerable than others.

The eighth case (No. 193) was very remarkable for the spontaneous recovery, by absorption, of severe suppurative iritis and keratitis. Such cases, though rare, are important in showing how careful we must be in framing a hopeless prognosis, or in ascribing a saving influence to a certain mode of treatment which may not deserve it.

The *average stay of a patient at the hospital was* 18 *days*, which is more than it was in Heidelberg (14 to 15 days). The greater number of complicated cataracts, and severe reactive processes I had to deal with in New York, may account for the difference. The shortest stay of any patient at the hospital was five days, the longest forty-six.

The following table on the

VISUAL RESULTS

speaks for itself. It differs from my former reports in so far as this time the final results, taken from the last examinations obtainable, were noted, while formerly I noted the results obtained by the examination at the time the patients left the hospital. At the time of discharge the reactive processes have commonly not yet entirely diappeared, the scar is not completely consolidated, opacities in the refractive media have not sufficiently cleared up, etc., to show final visual results. This is the reason why in my former reports V $\frac{20}{20}$ was never, and V $\frac{20}{30}$ only rarely mentioned. The primary results are noted in a proper column of the general table which may be consulted as a proof of the above assertion. While in this report the acuity of sight obtained ranks higher than in my former reports, there is this time a certain, though small, number entered as failures which in the former reports were entered as successes, namely such cases in which a later disease—for instance, detachment of the retina, irido-cyclitis, etc., or an after-operation—destroyed that

amount of sight which the patient enjoyed when leaving the hospital. Remarkable, in this series, is the small number of moderate results (7.5%), and this is certainly owing to the particular care that was taken during the operation to clear the area of the pupil as much as possible from the capsule and remnants of cataract. To clear the pupil I have never introduced a Daviel's or other spoon, since at the beginning of my career I received the impression that such instruments were commonly not more, but mostly less, efficient than the rubbing manœuvre, and were rather dangerous. Tough capsules were removed with forceps, which method I consider comparatively uninjurious. The rubbing procedure, however, while clearing the centre of the pupil, is apt to push shreds of capsule and remnants of cataract between the lips of the wound, where, as foreign bodies, in a certain number of cases, they awaken an inflammation which may jeopardize many an eye that otherwise would have been saved. I remember that *Von Graefe*, after the expulsion of the cataract, took less pains to clear the pupillary space than I have done. To clear the area of the pupil is certainly a good thing, but in doing it we should avoid pushing capsule, lens matter, and perhaps iris into the corneal section. I have of late, as the terminal step of the operation, tried, with delicate forceps, to grasp and exsect shreds of capsule which I supposed lying in the corneal wound, and have succeeded in this attempt. After the excision I passed a blunt spatula through the corneal wound with a view of shifting the capsule back into the eye, even if I could not see it. The results of this procedure, thus far, have been encouraging.

Final Visual Results.

S $\frac{20}{20}$	in	21 cases	or	11.5%
S $\frac{20}{30}$	in	25 cases	or	12.5%
S $\frac{20}{40}$	in	28 cases	or	14 %
S $\frac{20}{50}$	in	28 cases	or	14 %
S $\frac{20}{70}$	in	31 cases	or	15.5%
S $\frac{20}{100}$	in	24 cases	or	12 %
S $\frac{20}{200}$	in	7 cases	or	3.5%
Good result	in	164 cases	or	82 %

S $\frac{15}{200}$	in	4 cases	or	2 %
S $\frac{10}{200}$	in	3 cases	or	1.5%
S $\frac{6}{200}$	in	1 case	or	0.5%
S $\frac{5}{200}$	in	4 cases	or	2 %
S $\frac{2}{200}$	in	1 case	or	0.5%

Moderate result in 13 cases or 7.5%

S $\frac{1}{\infty}$ (perception of light with preservation of the shape of the globe) in 9 cases or 4.5%

S 0 in 14 cases or 7 %

Failure in 23 cases or 11.5%.

In order not to extend this paper too far, I shall here give only a brief account of the

AFTER-OPERATIONS

done on cases belonging to this series, so much the more because I intend at another time to discuss in detail this important subject, which of late has received so much attention by *De Wecker* and other authors. At the time when the general tabular statement was compiled, I had performed, on these 200 cases of extraction, thirty-three after-operations by methods and with results as follows:

I. *Division of secondary cataracts:*

a) with sickle needle 14; improved 13, unimproved 1;
b) with Graefe's knife 3; improved 2, unimproved 1;
c) with Beer's knife 4; improved 4, unimproved 0;

total 21; improved 19, unimproved 2.

II. *Iridotomy with Beer's knife and Tyrell's hook* 9, all improved.

III. *Iridotomy*, with fine scissors (not Wecker's, and previous to Wecker's publications) 1 case; eye lost.

IV. *Removal of old prolapse of iris*, 2 cases, result good.

Recapitulation: After-operations 33; improved 30, unimproved 2, lost 1.

ON KERATITIS BULLOSA.

By DR. M. LANDESBERG, of Philadelphia (formerly of Elberfeld).

The more exact knowledge of this form of disease is the result of recent investigations, especially those contained in the article "On the Diseases of the Cornea," by Dr. Saemisch in the "Handbuch der gesammten Augenheilkunde."*

This author was the first who attempted to gather the few notices scattered through the ophthalmological literature into a well-rounded picture of keratitis bullosa. By giving prominence to particular characteristics of this affection, he has succeeded in defining with precision its nature, and in distinguishing it from other diseases of the cornea similar in appearance. Before him, keratitis bullosa had shared the fate of so many other forms of disease: to be overlooked by some, mistaken and misjudged by others, and to be understood in its true nature by very few investigators only. With its introduction into the text-books, this highly important form of corneal affection has at last been assigned a position worthy of its dignity.

It is now the duty of specialists to give to this process of disease somewhat more active attention than heretofore; so that the picture of this form may be brought out with the same distinctness as other diseases of the eye which are entitled to no greater consideration; for the study of keratitis bullosa is far from being exhausted. On the contrary, the clinical work has only begun. Further researches and observations must furnish

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* See Handbuch der gesammten Augenheilkunde von Alfred Graefe and Th. Saemisch, IV. Vol., 1. Half, page 271.

the material for perfecting in all its peculiar features the picture of the disease, so that it may become known in all its various changes.

The study of keratitis bullosa has occupied my attention since the year 1869. At that time I had an opportunity of observing the first case of this kind in all its appearances. In the analysis even of this first case I was forced to the conclusion that I had before me an entirely new form of disease, which had nothing in common with the traditional classification of corneal diseases treated in the different text-books. Nor were the few notices of *V. Graefe* or *Weber* calculated to guide us through the labyrinth of theories. The first hint that was of any service to me in the study of this hitherto unknown affection I owe to *Von Hasner.*

But this case did not remain solitary. At different intervals cases came under my notice, and sufficiently often to keep my attention alive to these rare and peculiar phenomena. The more I studied the nature of this disease the more I became acquainted with its symptoms, the firmer became my conviction that the type of keratitis bullosa is one sui generis.

This treatise is based upon seven cases which came under my observation since 1869, in the following order: one respectively in 1869, 1873, and 1874; two each in 1873 and 1875.

The material is but meagre and hardly sufficient to settle the questions involved in the subject. I am fully aware how liable we are to err when we are compelled to draw our conclusions from a few isolated cases. What I present here is intended simply to furnish material for the further development of this part of our special science.

The notices on keratitis bullosa are extremely scarce in ophthalmological literature, as I have experienced while engaged in the study of this form of disease.

In the ante-ophthalmoscopic times, Beer is the only one in whose work I believe to have found any traces of keratitis bullosa. In the chapter on scrofulous inflammation of the eyes*

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*See: Lehre von den Augenkrankheiten von G. Josef Beer. Vienna, 1813, 1. B. page 5–3.

he describes *an ulcus icherosum which begins with a small vesicle containing a watery liquid; this bursts and forms a superficial semi-transparent ulcer, which steadily extends and presents ragged edges, readily causing hernia of the cornea* (ceratocele).

As the principal symptoms he designates intense pain, severe spasm of the eyelids, lasting for weeks, and notwithstanding all these inflammatory appearances but little tendency to iritis.

These features are in some points surprisingly similar to those of the affection under consideration, but the description is neither clear nor complete. A closer analysis of the complex of symptoms will soon show that more than one kind of corneal affection has served as objects for this form of scrofulous inflammation of the eye.

In this ophthalmoscopic period there exists in none of the text-books on ophthalmology a single allusion to keratitis bullosa, with the only exception of the latest collective work.

If we do not assume, what is improbable, that this affection has never been noticed by all these authors, we must take it for granted that they have confounded it with herpes corneæ, and have not considered it of sufficient importance, on account of its rarity, to distinguish it as a peculiar disease.

Hasner* is the first who describes the formation of vesicles on the cornea as a distinct form of disease; but even then in such a connection as we would least expect. Under the name of pemphigus corneæ he describes the following genuine case of keratitis bullosa, which I take the liberty to communicate in the form of an extract:

K. I., 40 years old, had suffered from kerato-iritis of the left eye, resulting in numerous posterior synechiæ, and a disk-like leucoma in the lower half of the cornea. The patient had formerly been treated by *Arlt*, who by means of iridectomy succeeded in arresting the disease.

On the 30th of March, 1863, the patient came into the eye-clinic of Hasner, having suffered for a fortnight from an inflammation of the hitherto healthy right eye. It presented the appearance of keratitis

* See: Klinische Vortraege ueber Augenheilkunde, von Dr. J. Ritter von Hasner, II. Abtheil.

punctata. Iris intact, prompt reaction on atropia, photophobia moderate. The process remained unchanged for four weeks; when, without any apparent cause, the photophobia increased, the circle of scleral vessels became more prominent, the dotting in the lower half of the cornea grew more visible; and one morning there appeared a pretty tense semi-globular vesicle, of $1\frac{1}{2}'''$ diameter, in the lower half of the cornea, accompanied by acute pain in the eye. On the following day the vesicle had burst, its membranous remains were lying in form of flakes on the surface of the cornea. The signs of irritation had decreased. After removal of the flakes the affected part of the cornea again appeared slightly punctured and dimly dotted. The regeneration of the epithelium was very rapid. Eight days afterward, and under the same symptoms, there appeared another vesicle, and this repeated itself frequently in periods of from 8–14 days, each seizure accompanied with severe ciliary neuralgia. After employing atropia, calomel, laud. liq. Sydenh. without any success, Hasner, on October 21st, proceeded to the operation of iridectomy. But this had just as little effect upon the course of the disease as the succeeding scarifications of the cornea.

The affection was arrested only by means of kerectomy, which Hasner performed on November 30th. Where the vesicle had been formed, he made a flap by introducing a cataract-knife between the layers of the cornea, grasped the flap with small forceps, and cut it off with a pair of scissors.

This put a stop at once to the ciliary pain. But moderate irritation, photophobia, and punctiform exudations on the posterior surface of the cornea remained during the winter. In April, 1864, a relapse took place in the upper border of the corneal cicatrix, by the development of a vesicle of the size of a hemp-seed, which was removed by partial kerectomy. With this the process ended, and patient was dismissed as cured on June 20th, 1864.

Hasner considered this case of the formation of a vesicle as an exceedingly rare one. He places it among the inflammatory affections of the superficial layer of the cornea, which he thinks justifies the name of pemphigus corneæ. Any further indication of similar observations is wanting.

Long before Hasner, Von Graefe, in his "Notiz über Bläschenbildung auf der Hornhaut,"* called attention to the forma-

* See: Archiv für Ophthalmologie, II. 1.

tion of vesicles in the cornea in the course of parenchymatous keratitis. He writes:

"In the progress of this disease there occurs sometimes, together with photophobia, previously not existing, a grayish disintegration, and then a protrusion in circumscribed spots of the corneal surface. There is gradually formed a fluctuating vesicle, which is usually of considerable extent; the lower part being generally more prominent, because the liquid gravitates downwards. These vesicles are extremely tedious and obstinately resisting medication. They are troublesome on account of their pressure and photophobia, which symptoms do not cease until after the spontaneous rupture of the vesicle. After their rupture, or after they have been removed, the photophobia disappears at once and a homogeneous greenish exudation takes place in the denuded superficial layers of the cornea. It ends with a perfectly transparent regeneration. The vesicles thus described are of very rare occurrence. At the points once attacked new vesicles are never formed after the rupture and necrosis of the walls of the first vesicle, but reappear successively at neighboring points, and sometimes the small perforation has been observed to fill up, so that the old vesicle became refilled in order to burst through a larger perforation."

If we compare this description of keratitis bullosa with the one given by Hasner under the name of Pemphigus corneæ, we at once perceive the fundamental difference, not only in the mode of observation, but also in the conception of the two forms of disease. Though the two descriptions differ in many ways respecting the appearances they present, we cannot fail to recognize a generic similarity between them.

Whilst Hasner defines pemphigus corneæ as an independent form of disease, we find that Von Graefe regards the vesicular formation only as one of the symptoms of a deeper morbid corneal process. According to his view, this formation of vesicles is only a rare phenomenon in the course of diffused keratitis.

Adolf Weber* observed the formation of vesicles in an eye affected with chronic iritis, in consequence of which aq. humor

* See: Archiv fuer Ophthal. VII. 1. Drei Mittheilungen aus der Praxis von Dr. Adolf Weber in Darmstadt.

had been dimmed almost to opacity. The cornea was involved in an independent inflammatory process, and showed at the first examination in the lower and inner quadrant:

"A group of 5 or 6 small vesicles, of the size of a pin's head, and a larger isolated central vesicle, all filled with a perfectly transparent liquid. There was no great irritation; the vesicles were not removed. Simple application of solutions of nitrate of silver relieved the patient of his pain, and caused the rupture of the vesicles. Only the central vesicle filled repeatedly whenever a congestive irritation of the iris occurred, in consequence of the frequent use of atropia, and was, of course, always accompanied by stinging pain.

"A few applications of solutions of nitrate of silver, or even a compressive bandage applied for a few hours, was sufficient to bring about a reposition of the raised epithelium, which finally was permanent."

This, too, is a form of vesicles which is not independent, but is developed in an eye already severely injured. In this respect the case is more closely related to the one described by V. Graefe, yet it differs materially through its milder course, and is totally different from the pemphigus corneæ of Hasner. Whether the case of Weber belongs at all to the category of keratitis bullosa is a question which I would hesitate to answer.

Saemisch* describes two cases of keratitis bullosa:

"One case was that of a man, 60 years old, who had never before suffered from any disease of the eye. Within a few weeks an extensive opacity had formed on the cornea of the left eye, presenting the appearance of small green stripes placed in different layers. The surface of the cornea appeared dim and tarnished. The iris was but indistinctly seen. Pericorneal injection moderate. In the course of the treatment, which consisted merely in applying atropia, the patient was attacked by keratitis bullosa, which, in spite of all remedies, repeated itself sometimes at intervals of 2 or 3 days, sometimes daily. To this trouble was added an acute glaucoma, with severe ciliary neurosis. Iridectomy here cut short the glaucomatous process, as well as the formation of vesicles. The cornea gradually cleared up, leaving only a moderate opacity."

"The second case is that of an eye blind in consequence of consecu-

* Handbuch der gesammten Augenheilkunde, l. c.

tive glaucoma. At the bottom of a parenchymatous infiltration, large vesicles were formed, which could not be removed by any means applied. The enucleation of the eye was the only resource."

Finally I cite from the same source (Handbuch der ges. Augenheilkunde), having no opportunity to consult the original articles:

1. The observations by Bowman of keratitis in an ill-fed woman, whose eye was destroyed by glaucoma.

2. The communication of Cowell on four cases of vesicles on the cornea.

This comprises the whole material which has hitherto furnished the basis for the interpretation of this rare affection of the cornea.

Therefore I do not think it superfluous to communicate in all their details those seven cases which have come under my observation.

Through the study of these cases must be formed a complete picture of keratitis bullosa, with all those peculiarities which, in my estimation, have not been appreciated by the authors as the essential characteristics of this morbid process.

FIRST CASE. May 5th, 1869.—L. S., son of a merchant, 8 years old. A thin, pale-looking child of scrofulous appearance. Face flaccid, livid; muscles flabby. No signs of specific hereditary diseases. His eyes were frequently affected with conjunctivitis, but free from any other serious affection.

Status præsens: Right eye normal. The lids slightly closed. Moderate photophobia. *Left eye*—The eyelids are spasmodically closed to such a degree that the cheek is drawn upwards, and the whole face disfigured, which is turned decidedly to the left, to avoid the irritation of the light. The head is turned down. No effort on the part of the child enables it to raise the lids, which are normal. The orbicular spasm can be overcome only by force. The globe is retracted into the orbit; the cornea is surrounded by a broad conjunctival swelling. The conjunctiva palpebr. is much reddened and swollen. Tears run profusely. The cornea, under oblique light, is clear and transparent in its upper third; in the centre slightly tarnished; the lower half presents a saturated opacity; in its centre there is a corneal ulcer with a consider-

able loss of substance. The bottom is of a muddy yellow color, covered with necrosed tissue and surrounded by abrupt and irregular edges. The infiltration penetrates to the deeper layers of the cornea. Laterally from the seat of the disease, there appear in the depth small groups of spots and points of irregular configuration. The marginal parts of the cornea are still transparent, but their surface is rough, as if covered with fine dust. The aqueous humor is free. Pupil much contracted. Iris hyperæmic.

Ciliary neuralgia at times very severe. The disease is somewhat intermittent. It has temporary remissions, during which, according to the statement of the parents, the eye bears the light very well and appears quite clear. These intermissions alternate with acute exacerbations accompanied by severe irritation.

Nothing certain can be stated about the duration and the cause of the affection. The child had been maltreated by the use of adstringents and derivatives.

In consideration of the distinct statement of the parents, I was obliged to suspend my diagnosis. I was inclined to consider the affection as a deep infiltration of the cornea.

Treatment was as follows: Protection against noxious influences, tonics, good diet, laxatives, atropia.

The pupil dilated in medium degree. No posterior synechiæ could be discovered.

Under this treatment the photophobia and spasm of the lids gradually diminished, and the cornea assumed a better appearance. The ulcerated bottom became clean; the opacity contracted gradually towards the centre, and greater portions of the cornea became transparent. Even in the deeper layers the infiltration subsided.

After the improvement had steadily progressed for six days, it was suddenly arrested, and the disease returned with renewed violence. The photophobia reappeared, spasms of the lids occurred at intervals. The reflection of the cornea became weaker and grayer; in the deeper layers there appeared separate groups of punctiform infiltrations with a diffuse yellowish halo, from which proceeded, in a vertical direction and parallel to each other, fine yellowish streaks, closely packed together. These increased in breadth, until at last they ran together and disappeared in the diffused opacity. The pupil remained dilated. Intraocular pressure normal. The ciliary neurosis very violent.

Called early on May 16th. I found the child with its face buried in the pillows, very unwilling to be placed upon its back. The expression of the face is so full of fear and pain, that I never before saw such a picture of terror in any corneal affection, and the impression made on my memory is indelible. The spasm of the lids and the irritation is so excessive, and the child so excited, that a closer examination can be made only under chloroform.

The ciliary injection forms a bright-red ring around the whole cornea. Conjunctiva bulbi highly injected. In the lower half of the cornea, about its centre, there is a pretty broad, fluctuating vesicle of oval shape, very much as if produced by a burn. It extends from the pupillary region to near the periphery of the cornea, upwards flat and flaccid, downwards broad and bulging. The contents consist of a yellowish fluid, which has settled in the lower part. The walls of the vesicle are firm. Pupil dilated. Humor aqueous free. Anterior chamber somewhat shallow. *Intraocular pressure increased.* The background of the eye, as far as can be ascertained, is unchanged, excepting a slight hyperæmia retinæ.

The treatment consisted of warm aromatic poultices, and repeated subcutaneous injections of small doses of morphia. The vesicle itself was not touched.

Towards evening a slight improvement could be noticed. The violence of the irritation was broken, the spasm of the lids diminished; ciliary neurosis only appearing at long intervals. This improvement lasted, with slight variations, for two days. On the third day, I found the vesicle had burst, leaving a roundish ulcer, with uneven, diphtheritic bottom, from the abrupt ragged edges of which there hung a few remnants of the walls of the vesicle. With the opening of the vesicle at once a considerable improvement took place. The irritation and inflammation diminished rapidly, and decided improvement commenced. It was surprising to see one symptom of disease disappear after the other as rapidly as they had appeared. The spasm of the lids subsided first; then the photophobia, leaving but slight traces. On the third day after the rupture of the vesicle, the intraocular pressure was found normal. How long it had been increasing could not be ascertained, as during the existence of the spasms of the lids a satisfactory palpation of the bulb was impossible.

Under the application of warm aromatic poultices and atropia the

appearance of the affected part improved. The yellowish opacity in the deeper layers of the cornea became more transparent, and gradually dispersed, small islands of the normal texture of the cornea becoming visible. The surface cleared up, and somewhat imperfect reflection began to return. The edges of the ulcerated bottom became more smooth and even, and the opacity of the lateral portions of the cornea gradually vanished. But during the reparative process, on the twelfth day after the first eruption of the vesicle, the scene again changed. Increased photophobia appeared; the episcleral injection became more pronounced; in the deeper layers of the cornea several small foci of infiltration again became visible, from which proceeded small parallel stripes. The surface of the cornea seemed loosened and swollen; reflection faded. On the fifteenth day, another eruption of a vesicle took place, with all the concomitant symptoms of irritation that we had witnessed before.

This time again an *increase of intraocular pressure was evident.*

The vesicle burst spontaneously on the second day. The further course of the process was exactly the same as described above.

And likewise in the later eruptions of vesicles, which repeated themselves in intervals of from eight to fifteen days, not the slightest change or variation in the course of the symptoms was observed.

During the whole period the iris had remained intact.

On July 29th, the last eruption of a vesicle took place. The process of repair was now as follows:

Reparation began from the deeper layers of the cornea. The yellow opacity gradually cleared up, separated into several small groups, then detumesced and became transparent, bringing into view the normal texture of the cornea, only a few specks remaining over the surface.

At the same time, but much more slowly, the process of repair began on the surface of the affected part. After the removal of the slough, the lost substance of the cornea was replaced by new tissue, up to the level of the yellowish infiltrated border which formed a line of demarcation of the healthy structure around. In this stage the wall of demarcation itself commenced its retrograde metamorphosis. The saturated opacity cleared up; the callosity disappeared and was gradually brought down to the level of the cornea itself. The ring was broken up into separate sections which, as pale, glistening stripes, divided by transparent tissue, preserved for a long time the configuration of the focus of

disease. In the centre of the lower half of the cornea, there still remained a superficial, grayish opacity, ending in leucoma.

Toward the end of the process, there was formed a broad band of extremely fine, closely aggregated vessels, which, starting from the limbus conj., extended beyond the lower periphery unto the wall of demarcation, where they abruptly ended, without projecting into the ulcerated surface.

The progress of repair was extremely slow, as we only find in keratitis parenchymatosa. The state of the disease remained unchanged for weeks. Irritation occurred frequently without any assignable cause. The slightest influences produced violent reaction. The episcleral injection never disappeared completely during the whole protracted healing process. Altogether the eye possessed very little power of resistance, and demanded unremitting care and attention.

Even after there was no further occasion to keep the boy from school, there could be observed, for a long time, after every unusual exertion of vision, the occurrence of a fine ring of episcleral vessels in the left eye, which disappeared, however, after a short rest. The final result, noted in January, 1870, was extremely gratifying. Almost normal vision, and Jaeger 1 from $2\frac{1}{2}''$—$13''$.

Second Case. April 4th, 1872.—Z. W., a freight agent, 38 years old, strongly built. General state good. Face expressive of much suffering. Conjunctival inflammations frequent for several years. The corneæ show several small nubeculæ.

Since the end of February the left eye is diseased. The affection has been considered by the family physician as of a rheumatic character, and treated as such, but without success. The phenomena of irritation and inflammation have increased; ciliary neurosis and spasms of the lids appeared; vision grew worse; on the cornea a green speck became visible. The course of the disease was not a regular, uninterrupted one. Acute exacerbations alternated with intermissions. From time to time all appearances of disease abated so far that patient could return to his occupation, until suddenly an unexpected relapse would seem to destroy all hope of recovery.

The last attack, three days ago, which took an unusually violent course, induced the patient to seek my advice.

Status præsens: Right eye normal. Slight conjunctival irritation. *Left Eye*—Great photophobia. Lids firmly closed; temperature increased. The patient is able to open them only by averting his face

from the light. Slight conjunctival swelling. Conj. bulbi hyperæmic. Episcleral injection considerable. Cornea in the upper half clear; in the lower half infiltrated. On the inner border of the pupil is seen an oval ulcer, deepest in the centre, though generally superficial, of yellowish color, and extending to the lower periphery of the cornea. From the upper margin of the ulcer hang shreds of epithelium, which partly hide the bottom of the ulcer. The lower margin merely shows a few remnants of the cast-off epithelium, surrounding the limbus conj. The deeper layers of the cornea are diffusely dimmed. Pupil very strongly contracted. Texture of iris slightly hyperæmic. Humor aq. and intraocular presssure normal.

Oblique light and ophthalmoscopic examination cannot be borne.

Therapeutics: Atropia, warm aromatic applications; rest in darkened room; subcutaneous injection of morphia. Tart. stib. in small doses.

The next day I found the pupil of medium dilatation, without synechiæ. Irritation considerably less. Spasms of lids diminished. Examination with oblique light is practicable, and gives the following results:

The lateral parts of the lower half of the cornea, covered by epithelium, and dimmed. The shreds of epithelium are to the greater part cast off from the ulcer. The margin itself appears somewhat abrupt, diphtheritic, and ragged. The bottom of the ulcer is uneven, yellowish, infiltrated. The yellowish infiltration penetrates all the layers of the cornea.

The background of the eye is not distinctly visible, the pupil being insufficiently dilated. But there seemed to be no pathological changes. During the following days the eye improved much. With the remission of all the symptoms of irritation, there was such a decided tendency to repair that I did not hesitate to let the patient come to my office. The ulcer had healed so far that I did not hesitate to apply the red precipitate ointment.

But on April 20th the aspect changed. The eye again presented symptoms of irritation and photophobia. The reflection of the cornea became dim; the parenchyma was loosened, swollen, with serous infiltration; in the deeper layers there appeared several small yellowish points. The irritation was increased on the following day. In the deeper layers the cornea presented several vertical stripes, and the yellowish points changed into diffuse ulcers.

April 22d I was called to see the patient. During the night his condition had become much worse. His suffering was unbearable. Anxious expression of face, which is spasmodically contracted on the left side. Patient insists that there must be some foreign body in his eye. He was not able to open it, despite his best efforts. A subcutaneous injection of morphia moderated the spasm of thelids sufficiently to enable me to open them and examine the eye.

On the affected part of the cornea I found a *broad vertical vesicle, filled with serous fluid*, which occupied its lowest portion. The epithelium of the lateral portions of the cornea is dim, fissured, a slight opacity radiating towards the upper half of the cornea.

Episcleral injection very great. *Intraocular pressure considerably increased.* Pupil moderately dilated. Humor aq. not quite clear.

I punctured the vesicle with a broad discission needle, and attempted to scrape off its walls, as well as the upper layers of the cornea, and then ordered warm aromatic poultices, atropia, and injections of morphia.

Within the next twenty-four hours the irritation and the ciliary neurosis decreased but very slightly. Intraocular pressure remained increased. I then determined to puncture the cornea and apply a compressive bandage.

This proceeding was successful. The crisis had been reached; improvement began and proceeded in the typical manner above described.

After the lapse of eleven days, there was another eruption of vesicle, which repeated itself frequently in intervals of from nine to twelve days. The characterisiic phenomena always were as follows: *Very great persistent increase of intraocular pressure; severe ciliary neurosis, and spasm of the lids.*

Paracentesis and subcutaneous injection of morphia proved to be the best remedies.

Upon the disappearance of the irritation and the infiltration of the deeper layers of the cornea, I resorted, in addition to the warm aromatic poultices, to daily application of calomel.

On the sixth of August, again the eruption of a vesicle took place with unusual severity of irritation. Opening the vesicle and puncture of the cornea were ineffectual this time. Intraocular pressure increased more and more during the next days. Even the humor aq. became dim, and on August 9th acute glaucoma had developed.

On the same day, I performed a broad iridectomy upwards.

After the operation, the intraocular pressure sank below the normal

standard. The pathological phenomena diminished, and the process of repair again commenced.

Though the iridectomy did not overcome the disposition to vesicular eruption, it had the effect *of preventing the increase of intraocular pressure during the eruption of vesicles.*

The morbid process extended into January, 1873. More than once I doubted whether the eye could be saved. The healing process was very slow. Though the deeper infiltration disappeared rapidly, the repair of the surface was very tedious, and at times remained stationary for weeks. The state of irritation seemed almost endless. When, in June, 1873, the patient was on the point of leaving the city, I found, in the absence of every exciting cause, the eye much irritated, painfully sensitive to light, with profuse secretion of tears. A firm cicatrix had formed on the affected surface.

Several pale-yellow points were found in the deeper layers of the cornea.

In August, 1875, I had the opportunity to see the patient again. He complained that his left eye was still irritable, although I was not able to discover any reason for his statement. There was a slight conjunctivitis on both eyes. On the left eye there was a good artificial pupil above. Leucoma circumscriptum corn. fere centrale.

R. M. $\frac{1}{20}$. V.$=\frac{15}{20}$. R. Jaeg 1. $6\frac{1}{2}''$—$12''$.
L. M. $\frac{1}{16}$. V.$=\frac{15}{100}$. L. Jaeg. 8.

Background of eye normal.

To complete the description of this case, it is important to add that we had to deal with an extremely careless patient, who, in spite of the most urgent injunctions, would expose himself to all kinds of injurious influences as soon as his pain ceased. Even during the paroxysms he disobeyed the directions of the physician so recklessly that I had reason to suppose he was bent upon the destruction of his eye.

THIRD CASE. Sept. 7, 1872.—S. H., file-maker, 22 years old, from Remscheid. A strong, healthy man. He stated that about eight days ago a small piece of metal had struck his left eye, which, notwithstanding all efforts, could not be extracted.

Status præsens : In the upper third of the cornea, a little outwards, an irregular, deep ulcer, surrounded by a diffuse yellowish zone of infiltration. Consecutive iritis. Strong episcleral injection. In the depth of the ulcer is seen a small rusty speck, which, upon closer

examination, proves to be one end of the foreign body, whilst the body itself lies in the anterior chamber.

Besides, there was a strabismus converg. and a small leucoma upwards and inwards, with a small anterior synechia.

Treatment: I introduced a broad iridectomy lancet into the anterior chamber, pressed its broad surface against the posterior wall of the cornea, forced the foreign body forward, and lifted it out by means of a chisel.

The one end of the piece of steel was firmly wedged between the lamellæ of the cornea, and only by gradually separating these, I succeeded in removing the foreign body. A perforation of the cornea, of course, could not be avoided.

Compressive bandage. Atropia.

The compressive bandage remained for three days. The anterior chamber was restored. Irritation very slight. Intraocular pressure normal. Pupil dilated. Infiltration disappearing.

Patient is discharged and advised to use warm applications and atropia. He was to return in a few days, but did not appear until Sept. 25th. The eye had become worse. The corneal infiltration had increased, extending nearly over the whole upper half of the cornea, and penetrating all its deeper layers. The surface of the cornea was not yet involved in the suppuration, but the epithelium appeared rough and raised. There was not much irritation. Photophobia very slight. Intraocular pressure normal.

Patient is again admitted into the Infirmary and treated with compressive bandage, atropia, and warm applications.

Patient could not bear the compressive bandage.

The state of irritation became worse. A severe spasm of the lids occurred, and under the symptoms of an acute ciliary irritation, a vesicle formed on the surface of the diseased cornea. Sept. 27th, the elongated vesicle extended from the pupillary region until near the upper periphery of the cornea, and was filled with a thin, yellowish liquid. Walls very firm.

Pupil dilated. Intraocular pressure normal.

Treatment: Division and removal of the vesicle. Subcutaneous injection of morphia. Warm aromatic poultices. Compressive bandage.

Again the patient objected to the compressive bandage, which was therefore removed.

The next day the site of the vesicle was covered with a roundish,

diphtheritic, irregular ulcer, with abrupt and callous edges. The irritation was diminished. A small hypopyon supervening did not have any injurious influence upon the improvement.

The reparation proceeded very rapidly. In a few days the deeper infiltration had dissolved into small, shallow ulcers, separated by healthy tissue. The superficial infiltration became more and more contracted, the lateral parts of the cornea again clearing up.

The bottom of the ulcer filled up and yielded a grayish reflection. With the exception of a slight episcleral injection, all irritation had disappeared.

Until the end of December, the formation of vesicles repeated itself six times, always announced by the appearance of several small ulcerations situated in the deeper layers of the cornea, from which points vertical parallel stripes proceeded, always accompanied by intense ciliary neurosis, spasm of the lids, and photophobia.

In four attacks, an increase of the intraocular pressure was evident.

Three times a hypopyon appeared on the day after the rupture of the vesicle, but without any influence upon the progress of the disease.

The above-mentioned treatment was pursued, and with the decrease of the irritation calomel was applied locally. Also, in this case, the healing process was as follows:

The deeper layers of the cornea cleared up first. The infiltration, separating into several islands, gradually disappeared, and normal texture of the cornea became visible. As a residue of the process, here and there a gray speck or point remained. A little later the surface underwent repair, the ulcerated bottom cleared and gradually rose to the level of the callous wall of demarcation. In the course of this process the rim had become shallower, divided into several sections, which indicated for a long time, in the form of pale stripes, the line of demarcation of the previous disease. In the commencement of the reparative process, a plexus of vessels developed at the limbus conj., which, extending beyond the corneal margin to the wall, ended abruptly in a broad base.

Recovery was slow, yet less tedious than in the other cases. There was no persistent irritation. At the end of January, 1873, patient was able to return to his occupation. A cicatrix was all that remained.

R. Hm. $\frac{1}{20}$. V.$=\frac{15}{20}$.

L. Hm. $\frac{1}{2}$. V.$=\frac{15}{50}$.

R. with + 18 Jaeg. 1, from 5″—14″.

L. with + 5 Jaeg. 5.

Fourth Case. October 2d, 1873.—L. W., four years old, shoemaker's son, from Barmen. Scrofulous diathesis. Panniculus adiposus strongly developed. Abdomen distended. Glands swollen. Eczema of the head, nose, and face.

According to the statement of the mother, the child has suffered for several weeks with its right eye. Extremely severe pains occurred periodically, accompanied by photophobia and increased secretion of tears. At such times the child was very restless, and buried its head in the pillows. These paroxysms disappeared after a few days, and improvement commenced. Then the child was quite cheerful, opened the eye, in which, with the exception of a small speck on the cornea, nothing morbid could be seen.

All domestic remedies had been exhausted, but no competent medical aid employed.

The child appears to suffer much, and is quite broken down. Seen from the right side, the face seems old, withered, and careworn. The head hangs down upon the chest, and is turned to one side.

Status præsens : Left eye—Conjunctivitis catarrh. and blephar. ciliar. *Right eye*—Considerable conjunctival swelling of the lids. Ciliary injection in the lower half, bright red; in the upper half, only slight. Conjunctiva bulbi much irritated and swollen. Cornea in the lower third intact only in its marginal parts. The central surface is covered by a deep ulcer, the bottom of which is diphtheritic and irregular, and the undermined, abrupt edges of which form a circular wall against the healthy parenchyma. The infiltration permeates almost the entire thickness of the cornea. Anterior chamber normal. Pupil very contracted. Texture of iris hyperæmic. Tension normal.

Therapeutics: Warm poultices. Atropia. Applications for the eczema. Iron and rhubarb internally.

The conditions improved somewhat. The mother did not return with the child till the tenth day. Judging from the agonized expression of the face, it was not difficult to form the diagnosis.

Both eyes were closed; but the left could be opened with ease. The lids of the right eye, however, were so firmly closed, and the fear of the child was so great, that no satisfactory view of the eye could be obtained.

An examination under chloroform confirmed my suspicion of the existence of keratitis bullosa. On the ulcerated surface I found a

pear-shaped vesicle with its base downward. Contents fluid, clear. Walls transparent, very resistant. Lateral parts of the cornea much dimmed. Upper half of the cornea somewhat tarnished. Pupil extremely contracted. Iris hyperæmic. Anterior chamber somewhat veiled and shallow. *Intraocular pressure increased.*

Therapeutics: Excision of vesicle and application of calomel.

The further treatment consisted in the use of atropia and warm poultices. The eye bore the somewhat severe measures without reaction. The result was favorable. Decrease of irritation and repair were rapid. The child, which remained in the Infirmary, visibly improved under proper care. This improvement continued for two weeks. With the exception of a mere trace, the infiltration of the deeper layer had disappeared; the bottom of the ulcer became filled up with granulations; the epithelium was already restored, when, without any assignable cause, the affection returned. The eye became irritated; in the deeper layers of the cornea there appeared again infiltrations, in small points of the size of a pin's head; which gradually ran into each other, and from which proceeded vertical stripes parallel to each other, accompanied by severe ciliary neurosis, spasm of the lids, and increased intraocular pressure; there finally appeared a vesicle. The pupil remained dilated. Humor aq. free.

The same treatment was adopted with similar success. Relapses were frequent. The case was not under sufficient control, because the parents could not leave the child in the Infirmary, and did not appreciate the necessity of a regular treatment. In consequence of the long duration of the disease, they thought the eye was lost, and quieted their conscience by consulting their physician only on extreme occasions.

Here, too, the morbid process was extremely sluggish and tedious. In the long intervals in which I saw the child, I could hardly observe any change in the state of the eye. Until late into the summer of 1874, I had opportunities to convince myself of the extremely slow improvement, and of the occasional relapses.

Lately I took occasion to see the child again, in order to complete the material for this treatise.

I found it generally much improved. The eye was clear; the pupil reacted normally. As the only remainder of the severe disease a circumscribed leucoma was visible in the lower periphery of the cornea. As far as could be ascertained by a superficial examination, no serious impairment of vision could be discovered.

Fifth Case. February 5th, 1874.—B. T., architect, 36 years old, from Barmen. Strongly built man, of good constitution.

Patient states that, in consequence of a cold, contracted a few days before, his right eye has become affected, without causing him any considerable inconvenience; that he had come as a measure of precaution, because he was about to set out on a long hunting expedition.

Status præs.: Left eye—Vision = $\frac{15}{20}$. Hm. $\frac{1}{30}$. With + 20 Jaeg. 1 from 5″—12″. Background of eye normal.

Right eye—Conjunctiva tarsorum, affected with catarrh. Slight hyperæmia of conjunctiva bulbi. Episcleral injection in the lower limbus corneæ in the form of a pink circle of extremely fine vessels, closely packed together, moderately developed. The lower half of the cornea appears veiled, dim; the upper half clear, normally reflecting. Iris, anterior chamber, tension normal. Pupil narrow and reacting slowly, compared with the left. V. $\frac{15}{70}$ Jaeg. 6.

Under oblique light, the surface of the lower half of the cornea appears rough, fissured, dotted, as if with a fine needle; in the centre, facet-like abrasions. In the parenchyma of the cornea there appear larger yellowish specks and points which, closely aggregated, form conglomerations from which project several vertical stripes. These infiltrations penetrate the whole thickness of the cornea, the upper segment of which, close to the pupillary region, is dimmed.

Medium dilatation of the pupil upon atropia.

Background of the eye, as far as can be seen, is normal.

I at first suspected the presence of keratitis diffusa, without excluding the possibility of kerat. bullosa. It was a matter of surprise, however, that notwithstanding these marked and far-advanced alterations of the cornea, the eye in general should manifest little reaction.

I warned the patient that a serious and obstinate disease was developing, against which it was necessary to employ effective means. He received my warning with incredulity, and did not consider himself in any danger.

Ten days afterwards patient sent for me.

As I had expected, my advice had been disregarded, all the more because another practitioner had made a totally different diagnosis.

Provided with sulphate of zinc and pills of aloes, the patient went out hunting, and for four days roamed about in the raw mountain air, exposed to all the injurious influences of the weather. The disease of

the eye grew worse. Severe pains set in, disturbing his night's rest.

In this condition the patient returned and consulted me.

On the right side of the face I again recognized the same expression of intense suffering which I had observed only in the paroxysms of keratitis bullosa. This picture of morbidly-distorted features was all the more surprising and impressive, as the other side of the face presented an entirely normal expression.

Status præs. : The lids are spasmodically closed. On attempting to open them, the hot tears ran down his cheeks. Photophobia and ciliary neurosis excessive. Episcleral injection very strongly developed. In the centre of the lower half of the cornea are two vesicles : a larger one, reaching almost to the margin of the cornea, is broad and tensely filled ; a smaller one, from the periphery inwards, is flat and of small dimensions. Contents of both fluid, clear. The lateral parts of the cornea infiltrated with serum ; the dimness radiating also upwards. The pupil is extremely contracted. Texture of iris hyperæmic. Humor aq. slightly dimmed. Intraocular pressure increased.

Upon the instillation of atropia the pupil dilates very sluggishly. Two threadlike synechiæ became visible. These afterwards disappeared under treatment.

According to the account of the patient, the vesicle must have existed for 24 hours.

Therapeutics : Excision of the wall of the vesicle. Atropia. Injection of morphia. Warm aromatic poultices.

Chloral produced no rest at night. Ciliary neurosis and photophobia as yet very violent ; but spasm of lids moderated. The bottom of the ulcer grayish, arroded. The edges ragged, callous, with yellowish-gray infiltration. In the deeper layers of the cornea a diffuse, complete dimness. Humor aq. dimmed.

Intraocular pressure increased.

I proceeded to paracentesis corneæ ; and a few hours afterwards raised the edges of the wound in order to empty again the humor aq.

Thus the acme of the process was broken, and the improvement commenced. The intraocular pressure became normal. The irritation gradually disappeared ; the infiltration decreased, and the process of repair became more decided.

Seven days afterwards, a return of vesicles, with moderate irritation. Again an increase of intraocular pressure.

On March 12th, another attack with very pronounced symptoms of irritation.

I adopted now the following treatment:

After excision of the wall of the vesicle, I proceeded to a scarification of the ulcerated bottom and of the deeper layers of the cornea, making a number of deep vertical incisions into the infiltrated parenchyma with the point of Beer's knife.

Thereupon, compressive bandage for twenty-four hours; which was well tolerated.

This course of treatment was pre-eminently successful and superior to all other methods previously employed. Already upon my evening visit (eight hours after the operation) I found the state of the patient much improved. The eye was quiet under the compressive bandage. Ciliary neurosis almost completely gone. To secure rest more completely, I made a small hypodermic injection of morphia and prescribed for the night chloral, if necessary.

Patient slept during the night without chloral. No pain had occurred. No spasm of lids. Ulcerated bottom with yellow infiltration. Edges somewhat callous. The lateral parts of cornea begin to clear up. The infiltration in the deeper layers of the cornea appears broken, more transparent. Irritation slight. Intraocular pressure normal. Pupil dilated. Humor aq. clear.

Under the application of warm poultices, atropia, calomel, repair and improvement progressed. The remission continued this time for thirteen days. Then the eye again became irritated. Small infiltrations occurred in the deeper layers of the cornea, from which proceeded vertical stripes; the swelling and infiltration of the superficial layers took place, and on the fifteenth day the eruption of a vesicle with the usual symptoms of irritation.

These attacks recurred three times up to the middle of May.

The process of scarification was repeated in every attack, and always *with the result of abridging the acute exacerbations and lessening their violence.*

From the middle of May the improvement progressed steadily, though slowly. A regular relapse did not take place; but the process showed some peculiarities, which we must examine a little more closely.

From time to time there were formed from one to two small vesicles upon the affected cornea, with very slight irritation, without the parenchyma being drawn into sympathy. *Slight transudation of the superficial*

layers, little photophobia and ciliary neurosis, the episcleral neurosis somewhat more prominent. Intraocular pressure remained normal. The patient had the sensation as if there were a foreign body in the eye.

These vesicles were very flat and mostly oval, with clear watery contents. The walls very thin and unresisting. A light pressure with the finger-nail, or even the application of powder of calomel caused the vesicle to burst. The wall was quickly cast off, and then remained a superficial light-yellow infiltration, which was absorbed already the following day. As before, the affected parts appeared of grayish color. The repetition of such vesicular formation occurred frequently at irregular intervals.

Upon the progress of reparation these interruptions had only the effect of retarding and, at times, of suspending the process. Other disturbing incidences did not occur.

The process of healing took place with the above-described distinguishing appearances: demarcation, filling up of the bottom of the ulcer, and formation of a bunch of vessels at the lower margin of the cornea. A firm cicatrix on the site of the affection remained. The morbid sequela continued for a long time. The function of the eye was not restored completely until autumn.

Final result: Vision $\frac{15}{50}$. Jaeg. 4.

SIXTH CASE. Sept. 20th, 1875.—V. N., 71 years old, weakly, decrepit laborer.

Status præsens : Left eye—Nearly in the centre of the lower half of the cornea an irregularly shaped, deeply penetrating infiltration with ragged edges, from which radiates a diffuse dimness over the neighboring parts. Irritation slight. Episcleral injection moderate. Lids lightly closed. Daylight can be borne. Anterior chamber somewhat shallow, differing but little from the right. Humor aq. clear. Pupil of medium dilatation. Intraocular pressure doubtful. though it gave to my finger the sense of morbid increase.

In oblique light, we observe the exudation penetrating the whole thickness of the cornea. The centre of the affected portion is slightly ulcerated. The lateral parts of the cornea are slightly punctured. The lens presents the usual signs of senile involution, with slight luxation upwards and inwards.

The ophthalmoscope reveals a clear, vitreous humor, but only a few vessels on the background of the eye.

Vision: counts fingers in immediate proximity.

Vision in right eye $\frac{15}{50}$. With + 7 Jaeg. 3 from 6″—10″. Even Jaeg. 2 in single words.

The statements of the patient are very inexact and unreliable. He says that some weeks ago, while at his work, a chip of wood struck his left eye, and from this he dates his eye-trouble. Then again he asserts that before the accident he spent several weeks in the hospital. But it was impossible to find out why he had been admitted into the hospital and whether his eye had been affected some time previous. Just as little certainty could be obtained whether the dilatation of the pupil was artificial or pathological.

Patient is admitted into the infirmary for the purpose of observation, and treated only with hot aromatic poultices. The aspect of the disease remained unchanged until Sept. 28th. The pupil remained dilated. On this day several punctiform exudations were observed in the deeper layers of the lower part of the cornea; at the same time the pre-existing infiltration seemed more intense. From this proceeded in a vertical direction several parallel stripes. On the dirty gray surface may be seen several little folds. The irritation was increased.

On Sept. 29th, *A vesicle and glaucoma acutum.*

After removal of the vesicle, *broad iridectomy inwards.*

Although the tension of the bulb was diminished by the operation, the intraocular pressure was still abnormal.

Under the compressive bandage the process of repair was rapid. The intensity of the intraocular pressure varied, yet within pathological limits.

On the fourth day, the bandage was removed. Irritation very slight. Intraocular pressure still increased.

On October 12th, under moderate phenomena of irritation: eruption of a small vesicle with clear contents. The intraocular pressure considerably increased.

Scarifications of the cornea, and, subsequently, warm aromatic applications.

No more vesicles were formed. The intraocular pressure became gradually normal. Reparation progressed without further interruption.

On October 21st, patient was dismissed, but continued to visit the clinic. My notice on November 15th is as follows: No relapse, intraocular pressure normal. Very slight irritation. The deeper infiltration has disappeared, except some few small grayish-yellow dots. Ulcerated bottom completely filled up, uneven, and of a grayish reflection. In

the place of the wall-like edges a narrow, flat, oval ring only is visible, forming a line of demarcation between the seat of disease and the normal texture. A broad tuft of fine vessels extends from the limbus conj. over the lower margin of the cornea, ending abruptly in the line of demarcation.

My last note of November 10th, 1875, is:

Complete cure with circumscribed leucoma corn. centr. Intraocular pressure normal. Beginning dimness of lens. Background of eye not visible. Finger at the distance of 2'.

Seventh Case. September 15th, 1875.—A. J., 20 years old, factory girl from Barmen. Scrofulous diathesis. Lips and nose swollen. Scars from abscesses of submaxillary glands. Slight degree of chlorosis. Any pre-existing affection of the eye is denied.

The left eye has been diseased for eight weeks. Cause of the origin unknown. Had been treated elsewhere before.

Status præsens: Conjunctiva bulbi strongly injected. Episcleral injection considerable. Photophobia moderate. The lids half open. In the lower half of the cornea is a diffuse spot of gray infiltration, extending from the pupillary region to near the lower margin of the cornea, and leaving but narrow borders intact. The infiltration penetrates deeply into the texture, the surface of which appears rough and uneven. In oblique light we observe the following appearances: the moderate infiltration is defined by an abrupt wall of demarcation, from which proceeds a diffuse opacity towards the upper and lateral parts of the cornea. The diffuse infiltration penetrates to the middle lamellæ of the cornea. Its deeper layers are pervaded by small finely granular exudations, several of which unite into small masses, being grouped behind the ulcerated surface. A broad cluster of vessels runs from the limbus conj. to the end of the ulcer, where it ends abruptly without projecting into the cornea.

Anterior chamber free. Pupil artificially dilated. Tissue of iris hyperæmic. Globe in ciliary region tender on pressure. Background of eye and intraocular pressure normal.

Therapeutics: Hot poultices. Atropia.

Under this medication the process of repair was rapid. The subconjunctival injection and the irritation disappeared almost entirely. Hyperæmia of conj. bulbi vanished. The infiltration contracted, gradually clearing up; the bottom of the ulcer became clear; repair of corneal substance commenced, and reflection, though dim, returned. The

deeper exudation also became more flattened and broken up into small points, leaving between them transparent intervals. To accelerate the cure, I applied a few days since ung. præc. rubr. (via humida par.)

On October 9th, the aspect changed without any known cause. Violent ciliary neurosis appeared, accompanied by strong episcleral injection. The surface of cornea appeared dim, raised, here and there punctured. In the deeper layers the small exudations are broader, mere prominent; they touch, and partly flow into each other, forming small foci of infiltration, from which proceed paralled stripes.

On the following day, the irritation was still more increased, and when I saw the patient on the 11th of October, I was able to form my diagnosis from the expression of her face.

On the left side of the face I again recognized the peculiar disfiguration, the typical expression of intense suffering, which I have already frequently pointed out.

The phenomena of irritation were very violent. Spasm of the lids so severe as to yield only to repeated injections of morphia. Globe somewhat sunken. On a broad infiltrated basis of the lower half of the cornea there arose two vesicles, of which the central one was large; the other inwards and downwards, had the shape of a small drop. The larger vesicle was distended with clear fluid; the smaller one flat, and only little distended. The walls of both transparent and resistant. Humor aq. clear. Pupil dilated. Intraocular pressure hard to define on account of the spasm.

Therapeutics: Scarification of the cornea after previous ablation of the vesicle. Warm poultices. Atropia. Chloral hydrate.

On the day after, the violence of the attack had somewhat abated. The cornea presented the appearance of a deeply penetrating diffuse infiltration. Humor aq. turbid. Small hypopyon. Intraocular pressure increased.

The eye improved during the following days. The infiltration had contracted towards the centre; the deeper layers of the cornea cleared up, leaving but point-like exudations. The ulcer became clean, and repair proceeded in the manner above described.

Under the same svmptoms of irritation there was a relapse on October 21st, November 11th and 18th, December 3d, the course of which was in every detail similar to those above described.

December 10th. Since the last eruption, the force of the process seems broken. The reparation takes a regular course, though it is very

slow. From time to time the aspect is altered by the appearance of one or two small vesicles which rise from the infiltrated base of the diseased part. They are moderately filled with clear transparent contents; the walls are very thin. The mere application of calomel is sufficient to cause them to burst. They do not leave an ulcerated bottom and are accompanied only by moderate irritation. With the bursting of the vesicle every disagreeable sensation ceases, and the cornea soon resumes its previous aspect.

Sometimes it does not come to the formation of a regular vesicle; but with increased subconjunctival injection, a small part of the corneal epithelium is raised. This phenomenon ceases of itself.

December 18th. Appearances of irritation slight; no photophobia, conjunctiva bulbi but little hyperæmic. Slight episcleral injection. The centre of the lower half of the cornea presents a gray-reflecting, dim and uneven surface. The seat of disease is completely surrounded by a low, glistening wall, from which a superficial dimness proceeds to the lateral parts and the upper half of the cornea. In the different lamellæ of the deeper layers of the cornea there are points like exudations, here and there forming conglomerations, between which the normal texture of the cornea is visible. A cluster of vessels runs from the limbus conjunct. to the lower margin of demarcation, ending here abruptly.

Therapeutics: Atropia. Warm poultices. Applications of calomel.

January 10th, 1876. The process of repair is normal. Further eruptions of vesicles have not occurred. A slight irritation yet exists. The lower part of the cornea is superficially dimmed. The deeper layers are transparent, and still present here and there small specks and dots. The pupil is of medium dilatation. Background of the eye and intraocular pressure normal.

Therapeutics. Same as above.

I had no further opportunity to follow up the case.

In opposition to Hasner, who considers the case of vesicles of the cornea, described above as pemphigus corneæ, as "an inflammatory affection of the superficial layers of the cornea," we must regard keratitis bullosa as a form of disease which takes its starting point from the deeper layers of the cornea itself, and produced by inflammation. Keratitis bullosa must, therefore, be strictly separated from all superficial inflammations of the

cornea, and especially from herpes corneæ, to which it has not the slightest relation, neither in its pathogenesis, nor in its course, nor in the concomitant symptoms. Fundamentally different as both these forms of disease are, only a complete misapprehension of all the pathognomic facts could have led to this confusion. Keratitis bullosa presents an independent form of parenchymatous infiltration of the cornea, in which the formation of vesicles is only a consequence. We must assume with Saemish that it is the result of a mechanical process, produced in such a manner that the exudation either separates the epithelium alone, or, at the same time, the anterior homogeneous lamella, thus forming a vesicle.

This view is justified by the nature of the process itself, and by all its appearances and progress. In this form of disease the corneal tissue itself is seriously affected from the beginning. Together with the inflammatory process there appears on a circumscribed spot loss of cohesion, swelling and dimness of the parenchyma. Infiltration increases with the progress of the disease; small and separated foci of suppuration are formed between the lamellæ of the cornea, ending in disorganization and molecular disintegration. The inflammatory exudation collects in the interstices of the cornea, penetrates the different layers to the epithelium, which is raised simply by mechanical pressure. Thus the vesicle is formed on the cornea. This is, therefore, merely the final effect of each inflammatory process, constituting only a secondary symptom, while the inflammation of the parenchyma of the cornea is the primary part of the disease. No vesicle is ever formed on healthy corneal tissue. With the rupture of the vesicle, and the effusion of the serous fluid, the acme of each attack is reached. Irritation diminishes, infiltration recedes, the texture resumes its transparency, the epithelium is regenerated. Thus the improvement continues for a while, until the inflammation, kindled anew, causes a fresh relapse, and the disease again runs the course described. Thus, we have before us a "circulus vitiosus," until, finally, the cause of the disease is exhausted, and the tendency to heal prevails.

We may, therefore, characterize this form of disease as "*a deep*

and localized inflammation of a part of the cornea, with the tendency to acute exacerbation, of which the vesicle on the surface is only the last link of the chain of symptoms.

Having thus established the nature of the disease, it remains for us to investigate more closely those peculiarities which characterize keratitis bullosa. From a study of the previous cases we sum up the following facts:

1. *The different phases of the morbid process.*—The disease presents various aspects, which run their course under dissimilar appearances. In its several stages of development there is no uniformity. The form of the acute exacerbation is just as characteristic as that of the succeeding one in which the vesicle is ruptured, and the surface of the diseased part exhibits an infiltrated ulcer with its steep edges. Just as peculiar is its latent state. Here, where the deeper layers of the cornea, otherwise transparent and clear, betray an abnormal condition only by a few scattered dots and specks, one might infer from the grayish reflex of the uneven surface of the cornea, and from the form of the line of demarcation, rather a superficial inflammation than a deep-seated and dangerous change of nutrition of that tissue. In this manner changes the aspect of the disease, seemingly without any inner connection between its various phases. And still the prominent character is a uniform one, and the different changes are only sequences of one and the same morphological process.

2. *The tendency to localization.*—The focus of disease in the cornea is from the beginning distinctly circumscribed. In all relapses the infiltration is confined by the same limits set from the beginning. May the reaction be ever so violent, and the intensity of the inflammation ever so high, the process always repeats itself on the seat of the old affection limited by the surrounding wall. There is no disposition to transcend the original limits. Though the disease is deep-seated, and penetrates nearly all the layers of the cornea, it never ends in a rupture nor in intimate involvement of the membrana Descemetii, *i. e.*, hypopyon.

3. *The intermissions and exacerbations of the morbid process.*—

This peculiar change in the condition of the eye, the almost complete disappearance and then sudden reappearance of all the inflammatory phenomena form the most prominent symptoms of keratitis bullosa. I never had occasion to witness the same series of symptoms in any other disease of the cornea. All the others observe a typical course. Slowly progressing the process reaches its crisis, remains stationary for a time, and gradually changes, to end in recovery. But if the tendency to recovery has once set in, if repair has once begun, we may with certainty predict that the improvement will be steady and continuous if no disturbing causes happen to interfere. Not so with keratitis bullosa. Most of the inflammatory symptoms may have completely ceased, the process of repair may be completely established, we suddenly witness, without any assignable cause, an acute repetition, with all the symptoms of extraordinary irritation. In this manner the exacerbations alternate for a long time with free intermissions, and we cannot determine with any certainty the end of the morbid process.

4. *The extremely rapid course of the inflammatory phenomena.*—Despite the deep disturbances of nutrition of the cornea, which is caused by the acute exacerbations, the process is a comparatively short one. Immediately upon the rupture of the vesicle, infiltration diminishes, irritation abates, and reparation sets in anew. The resorption of the exudation is often so rapid that with the third or fourth day the deeper layers have regained their transparency. The ulcer assumes a healthy appearance somewhat later, though even in this affection the epithelium may be completely restored in a few days. The opacity alone of the superficial layers of the cornea remains stationary, which does not clear up completely until the whole morbid process is ended.

5. *The unusual phenomena of irritation on the part of the nervous system.*—Here, too, we find nothing analogous in other diseases of the cornea, not excepting herpes corneæ. There are pre-eminently two symptoms, which by their peculiarity attract the physician's attention from the very first. These are:

a) The spasm of the lids.

b) The distortion of the features.

The spasm of the lids in the acute stage of the affection is so severe, that in most cases it cannot be overcome by any other means than complete anæsthesia. The reflex phenomena in the region of the facial nerve are so characteristic of this affection, that afterwards having become more intimately acquainted with this form of disease, I could make my diagnosis from the expression of the face.

6. *Increase of the intraocular pressure during the acute stage.*—This symptom is constant in all cases in which irritation is very violent. Its duration is in exact proportion to the violence of the exacerbations. In all cases in which the violence of the irritation was broken with the formation of the vesicle, the intensity of the intraocular pressure decreased. In such cases, however, in which the symptoms of irritation continued longer, the increase of the intraocular pressure likewise persisted. Only in the later stages of the process, where the vesicles were formed without violent irritation, intraocular pressure either did not increase at all, or occurred without regularity.

7. *The immunity on the part of the iris and choroidea.*—Notwithstanding the temporary violence of the irritation, and the long duration of the affection, and its sluggish course, the process manifested no tendency to involve the iris or the choroidea. If the disease is carefully watched in the beginning, we can always preserve the iris from being attacked. By atropia we may obtain either a complete mydriasis or a medium dilatation of the pupil. In the last instance hyperæmia of the tissues often occurs, which is of no importance. Synechiæ have never been observed. Only in neglected cases have I discoved a few thread-like adhesions. Even these we were enabled to break, and to restore the pupil to its normal condition. But in no case whatever I have observed that the choroidea was secondarily affected.

The complications which altered the course of keratitis bullosa are:

1. Hypopyon.
2. Secondary glaucoma.

All cases of hypopyon coming under observation, were mere

secondary symptoms consequent upon the scarification of the cornea. The sinking of the pus into the interior chamber has, therefore, no direct connection with the corneal process, but must be considered as an incident of the scarification. The hypopyon exerted no influence on the process. It disappeared within 24 hours, without causing further disturbances.

From an entirely different point of view must we consider the appearance of glaucomatous processes, which were twice observed in keratitis bullosa.

One case of acute glaucoma (in case 2) is without doubt a consequence of keratitis bullosa, and must be regarded as directly connected with it. The entire course of this case has been closely observed and noted by me. There were no other causes for the development of glaucoma. But it was different with the case in number 5. Here it is difficult to determine which of the two phenomena was primary, and which secondary. The patient came late under my observation. At the first examination already, there existed an increase of intraocular pressure and dilatation of pupil. But the signs of a serious corneal affection were not the less prominent. However, as vesicles have been observed in instances where deep nutritive disturbances of the cornea followed serious intraocular disease, it cannot be decided here whether a long-continued glaucomatous condition had involved the cornea, and produced the vesicles, or whether the corneal disease was the origin of a consecutive glaucoma. From the patient himself—as already stated—nothing could be ascertained. From the further course, and the success of the iridectomy, I am inclined to believe that the glaucoma was the primary affection, the corneal disease its consequence.

Be this as it may, a connection between the keratitis bullosa and the glaucoma cannot be denied. The increase of the intraocular pressure has in all cases been observed as a constant symptom in the stage of acute exacerbation. Consequently every eye suffering from keratitis bullosa is liable to be seized with glaucoma. For all the conditions are present. It depends only upon external circumstances, whether the process will develop a glaucoma, or whether the glaucoma will remain in the

prodromal stage, and the equilibrium will be re-established without deeper morbid alterations. The following factors decide the development of one or the other process.

1. The elasticity of the capsule of the eye and the resistance which it opposes to an increased pressure.

2. The lateral pressure of the vessels in the interior of the capsule.

3. The condition of those parts, which give shape to the capsule, *i. e.*, the vitreous humor, and humor aq.

Every disturbance in one or the other factor, every disproportion in the regulating forces, must cause a disturbance of equilibrium, and produce either an increase or a decrease of the intraocular pressure. In the great intensity of ciliary irritation, accompanying the acute stage of keratitis bullosa, will be found all the predisposing moments for glaucoma. The irritation of the branches of the trigeminus, which enter and end in the interior of the eye, is reflected upon vasomotor or secretory nerves of the eye, and secondarily gives rise to a neuralgic increase of secretion. Whether it will lead in one case only to increased intraocular pressure, in another to glaucoma, depends upon the amount of secretion.

Upon the *Ætiology* of this form of disease my researches throw but little light. Only in one case (III.) I could determine as a cause of the affection, injury of the cornea by a penetrating foreign body. In all other cases the result of the research was negative. Although in one or the other of my patients I was able to discover a so-called scrofulous diathesis, yet the agency of scrofulosis remains as unsettled in these cases as in the other pathological conditions of the eye. Antecedent disease of the eye may be excluded with certainty in 6 cases.

In one case (VI.) the history of the disease is uncertain; the serious corneal affection was probably a consequence of a deep nutritive change of the organ. In the great majority of cases, however, the affection appeared in eyes which had until then been perfectly sound. No cachexia, no constitutional and no cutaneous diseases were present.

The *Diagnosis* of keratitis bullosa is not easy, and errors are

difficult to avoid. Nothing but the observation of the acute stage, with all its concomitant symptoms, furnishes reliable indications. It is impossible to judge the character of the affection from the peculiar infiltration of the deeper layers of the cornea, or from its situation and form. It is easy to confound it with keratitis diffusa. The latent state points to everything else but keratitis bullosa. The statements of patients are worthless.

The *Prognosis* is generally not unfavorable, notwithstanding the severity and long duration of the disease. The only complication to be dreaded is glaucoma. Otherwise the eye tolerates the greatest insults without any serious results. The uveal tract has never been involved in the morbid process. Even the corneal process results favorably. As above stated, the infiltration has no tendency to extend, and the seat of the disease is circumscribed. A perforation of the cornea does not occur. The changes which the cornea undergoes in this disease generally produce no especial disturbance of function in this membrane. Recovery takes place either with a circumscribed leucoma, or a superficial dimness of the cornea. In either case there is only slight impairment of vision. The treatment can only be palliative and symptomatic. I know of no remedy to arrest or shorten the process. Relapses cannot be prevented. The best results have been obtained by the scarification of the cornea. They always serve to shorten the paroxysm, and to lessen the intensity of the process. Not less favorable appeared its influence upon the rapid resorption of the infiltration and the removal of the dimness of the cornea. They have certainly not prevented the relapses, though it appeared as if the free intervals were extended by the scarifications. The incisions into the cornea must be deep and numerous. This treatment is likewise adapted to visiting patients. The eye bears the operation well, and its success is visible on the following day.

I have derived no benefit from the compressive bandage when used alone. Some patients do not tolerate it at all, and where it is borne it is usually superfluous.

Calomel I have applied both in the stage of exacerbation and of reparation. Even during the stage of the high inflammation the application of calomel produces no marked reaction. But I have never observed any particular benefit from its use, except that it causes the rupture of small vesicles. When repair has once commenced, the application of calomel, or yellow ointment, or of any other irritant exerts no influence upon its progress. The process reaches with, or without, these remedies a certain stage, and then remains stationary. If there were no relapses for a longer time, and the process of repair seemed to be persistent, I preferred the yellow ointment and believe that its continued application exerted a favorable influence upon the formation of the cicatrix.

In all cases where the intraocular pressure attains a dangerous intensity, paracentesis corneæ must be performed. The result is always favorable.

I have derived much benefit from the application of warm aromatic poultices even in the stage of repair. They proved the best sedative for the irritation after the puncture of the vesicle, and the scarifications.

I have made extensive use of atropia, without any unpleasant consequences. The pupil must be kept dilated for a long time, even for months, long after every symptom of irritation has disappeared. *While there is any ciliary irritation, when the patient wakes up in the morning, the use of atropia must be continued.* The eye should be watched for a long time, and remain protected against all injurious and irritating influences. For the eye has lost its power of resistance and is incapable, long after the cure, of performing even moderate duties. Hence rest of the organ is absolutely necessary.

Great benefit is derived from repeated hypodermic injections of morphia in considerable doses to overcome the excessive spasm of the lids. Even in the case of the child I used them without any disagreeable effects. The result was surprising and lasting. It is almost superfluous to state that the hypodermic injections proved useful against the ciliary irritation.

Where the subcutaneous injection could not be repeatedly

applied, the internal use of chloral hydrate proved a good substitute.

In case II., iridectomy had no effect whatever upon the frequency of the relapses, and the violent symptoms of irritation. But it controlled the degree of intraocular pressure, which in this case remained normal during the subsequent course of the disease.

In case VI., the iridectomy seemed to have a favorable influence also upon progress of the disease. After the operation the eruption of a vesicle recurred but once. Repair proceeded very rapidly, without presenting that slowness of progress, which we witnessed in every other case.

CLINICAL REPORT OF 3,873 EYE-PATIENTS, TREATED AT THE NEW YORK OPHTHALMIC AND AURAL INSTITUTE DURING THE YEAR 1876.

BY DR. AD. ALT, ASSISTANT AND RESIDENT SURGEON.

THOUGH a simple statistical report of the workings of the New York Ophthalmic and Aural Institute has been given every year, and remarkable cases have been reported by the surgeons, a clinical report has not yet been published. The considerable number of patients treated in the Institute, and my position as house surgeon affording me an excellent opportunity of thoroughly observing the cases, prompt me to collect the instructive material in the shape of a more detailed clinical report.

I. STATISTICS.

The number of *new* eye-patients, treated during the year 1876, was 3,873. The following table I. shows the statistics of the various diseases that came under observation, and their relative frequency from month to month.

TABLE I.

I. AFFECTIONS OF THE CONJUNCTIVA.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Conjunctivitis, catarrhal chronic,	36	42	60	45	45	68	58	43	30	40	43	38	548
" " acute,	2	7	7	8	12	3	2	1	1	8	11	5	67
" with blepharitis,	11	12	9	9	9	9	2	8	17	16	18	14	134
" blennorrhoic,	12	8	16	10	10	12	12	28	48	28	11	15	210
" " of the new-born,	2	1	5	3	2	1	6	6	2	3	1	2	34
" gonorrhoic, .	1	2	1			1	2	2		2	1		12
" croupous, .			1	1									2
" diphtheritic, .	1				1					1	1		4
" phlyctænular,	19	7	16	18	20	20	13	9	5	9	11	13	160
" traumatic, .		2	1	1		2		3			1	3	13
Trachoma, ...	18	21	11	19	21	22	18	29	33	30	21	24	267
Subconjunctival hemorrhage,			2	5	1	5	3	2	1	3		1	23
Symblepharon, ...	1							1	1				3
Tumor, ...					1				1		3		5
Foreign body, ...	1	1		1	3			3	1	1	2		13
Pterygium, ...	1			2			1		1				5
Lymphangiectasia, ...	1	1									1		3
Burn, ...							1	1			1		3
Total, ...	106	104	129	122	125	143	118	136	141	141	126	115	1506

II. AFFECTIONS OF THE CORNEA.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Circumscribed infiltration, .	7	1	1	1	2	2	1	2	2	1	1	3	24
Keratitis, phlyctænular, . .	18	23	22	26	28	44	24	14	23	12	17	10	261
" " marginal,	5	3	9	7	9	5	9	2	5	4	8	5	71
" pustular, ...	2	5	11	6	7	3	4	2	3	1	7	5	56
" parenchymatous, .	4	4	4	6	7	6	5	5	5	4	5	4	59
" purulent (cum hypopyo)	2	2	6	2	2	3	4	2	1		2	1	27
" superficial ulcerous,	1	2	2	3	1	5	6	2	1	1			24
" fascicular, . . .			2	2			1						5
" ribbon-shaped, . .		2								1			3
" traumatic, . . .		1	3	4	2	1	2	2	1	3		1	20
Kerato-iritis, ...	2	2	7	1	4	1	6	3	6	3	1	7	43
Pannus, trachomatous, . . .		2	1	3	3	1		1	1	1		1	14
Ulcer, simple, ...	1		1	1	3	3	3	2	2		3	1	20
" perforating (prolapse of iris)	1	1					1						3
Macula, ...	8	3	5	7	3	7	5	5	5	10	5	5	68
Leucoma, simple, ...		2						3					5
" adherent, ...	1	3	3	2	2	2	2	1	1	1	3	3	24
" total, ...			1										1

II. AFFECTIONS OF THE CORNEA—*Continued.*

	J.	*F.*	*M.*	*A.*	*M.*	*J.*	*J.*	*A.*	*S.*	*O.*	*N.*	*D.*	*T.*
Staphyloma, ...	1	1	1	2	1	2	1	4	2	3	1		19
Keratoconus, ...		1										2	3
Foreign body, ...	7	9	11	8	13	5	7	12	8	10	6	3	99
Wound, ...	1		1		2							2	6
" with prolapse, . . .		3			3		4	2		2	1	1	16
Cystoid scar, ...					1								1
Burn, ...	1		1	2	2	1	2		2	1			12
Total, ...	62	70	92	83	95	91	87	64	68	58	60	54	884

III. AFFECTIONS OF THE SCLEROTIC.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Episcleritis, ...		4	1	1	1		2	1	3			1	14
Wound, ...										2		1	3
Staphyloma, ...		2			1	1				1			5
Total, ...		6	1	1	2	1	2	1	3	3		2	22

IV. AFFECTIONS OF THE IRIS.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Iritis, simple acute, . . .	2	6	2	3	3	3	3	9	4	5	4		44
" " chronic, . . .			1	2	1			1				1	6
" specific, ...		2	5	3	1	1	3	1	1	1	1	2	21
" gummous, ...			1		2		1		1				5
" serous, ...	1		1	1	1	1	1	1	1		2		10
" purulent, ...				1									1
" sympathetic, ...	1			1							1		3
Irido-cyclitis, ...	1		1	1		1			1		1		6
Irido-choroiditis, ...		3	2	1			2	2	1	2	2		15
" sympathetic,												1	1
Posterior synechiæ, . . .			1						1				2
Occlusion of pupil, ...	1					3						1	5
Tumor, ...		1											1
Mydriasis, traumatic, . . .				1									1
" medicamentous, .	2		1	1	2		2	2		3	1	3	17
" spontaneous, . .	1				1	1							3
Myosis, spinal, ...		1						1					2
Coloboma, ...									1				1
Foreign body, ...												1	1
Irido-dialysis, ...	1				1								2
Hyphæma, ...					1			1					2
Total, ...	10	13	15	15	13	10	12	18	11	11	12	9	149

V. AFFECTIONS OF THE CILIARY BODY AND CHOROID.

	Jan.	*Feb.*	*Mar.*	*April.*	*May.*	*June.*	*July.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Total.*
Cyclitis, ...	1											2	3
Hyperæmia of choroid, . .	1								1		1		3
Choroiditis, serous (ablatio retinæ)		1	1	1	1	2	1				1		8
" " in myopic eyes,			2	1	2				2			1	8
" atrophic (disseminate)	2	3	3	1	3	2			1	1	3		19
Chorio-retinitis, specific, . .				2	2		1		4	1			10
Hemorrhage, ...		1											1
Rupture, ...											2		2
Albinism, ...								1					1
Melano-sarcoma, ...									1				1
Total, ...	4	5	6	5	8	4	2	1	9	2	7	3	56

VI. GLAUCOMA.

	Jan.	*Feb.*	*Mar.*	*April.*	*May.*	*June.*	*July.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Total.*
Glaucoma, subacute, . . .			1						1				2
" hemorrhagic, . .				1									1
" chronic simple, .	1	3		3	4	4	1	6		1	5	1	29
" absolute, . . .							1	2					3
" consecutive, . .		1		1	1	1							4
Total, ...	1	4	1	5	5	5	2	8	1	1	5	1	39

VII. AFFECTIONS OF THE OPTIC NERVE AND RETINA.

	Jan.	*Feb.*	*Mar.*	*April.*	*May.*	*June.*	*July.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Total.*
Hyperæmia of retina, . . .		1			1			1					3
Neuritis, optic, ...								1					1
Neuro-retinitis, ...			2	2					1	2		2	9
" sympathetic, .						1		1					2
" ex morbo Brightii,	1		1	1				1	1	2	1		8
Retinitis, hemorrhagic, . .	1			1				1	1		1		5
" pigmentary, . .	1	1		1	1	1				1	1		7
Retino-choroiditis, central, .			1	1	1		2	2				1	8
Atrophy of optic nerve, idiopathic	3	2	2	6	5	2	7	2	2	7	3	2	43
Atrophy of optic nerve, after neuritis, ...			1			1							2
Atrophy of optic nerve, congenital			1										1
" " " cerebral,	1												1
" " " spinal,							1	1					2
Embolism of central retinal artery	1												1
Tumor, ...										1	2		3
Opaque nerve-fibres, . . .						1		1					2
Total, ...	8	4	8	12	8	6	10	11	5	13	8	5	98

VIII. AMBLYOPIA.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Amblyopia, ex abusu, . . .			2		1			3	2			1	9
" cerebral, . . .						1							1
" congenital, . .							1						1
" from central scotoma,						1	1						2
" from anæmia, .				1									1
" cause unknown, .			2	1	1						1		5
Hemiopia, ...					1								1
Total, ...			4	2	3	2	2	3	2		1	1	20

IX. AFFECTIONS OF THE CRYSTALLINE LENS.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Cataract, senile hard, mature,	3	2	9	8	9	8		3	3	9	3		57
" " immature, progressive,	6	4	4	3	6	2	5	7	2	6	2	3	50
" " hypermature,	1		1	1	1	2			1	3		1	11
" soft, ...	1				1	1					1		4
" zonular, ...		1	2										3
" posterior polar, . .		1		2						1	1		5
" traumatic, . . .	4	1	3		1	1	4	3		4	3	1	25
" secondary, . . .	1				1		1	1	1	2			7
" chalky, ...			1										1
" pyramidal, . . .		1			1	1		2			1		6
" glaucomatous, . .				1			1						2
" accreta, ...	1			3	1	1						1	7
Dislocation of lens, traumatic,			2			1	1	2	1	1			8
" " spontaneous,								1					1
Total, ...	17	10	22	18	21	17	12	19	8	26	11	6	187

X. AFFECTIONS OF THE VITREOUS BODY.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Muscæ volitantes, ...	2		2	2		1	2	1	2	1	2	1	16
Opacities, simple, ...				2				1		1			4
" membranous, . .						1				1		1	3
Hemorrhage, ...							1		2				3
Total, ...	2		2	4		2	3	2	4	3	2	2	26

XI. AFFECTIONS OF THE GLOBE.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Hæmophthalmus, ...	I												I
Phthisis, anterior traumatic, .	I		I	I	I			I			I	I	7
" " from gonorrhœa,								I	2				3
Foreign body in the eye, . .	I	I			I				I	I			5
Phthisis, total traumatic, .	I				3	2		I		2	I		IO
" " from blennorrhœa,			I		I					I			3
" " from blennorrhœa of the new born,							I						I
" " from other causes,					I	I						I	3
Hydrophthalmus, ...												I	I
Microphthalmus, congenital, .			I							I	I		3
Anophthalmus, after enucleation,											I		I
Total, ...	4	I	3	I	7	3	I	3	3	5	4	3	38

XII. ERRORS OF REFRACTION.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Myopia, ...	6	4	3	4	4	6	5	4	2	2	9	I	50
" with posterior staphyloma	4	4	2	4	7	4	4	5	6	7	I	6	54
Hyperopia, ...	I2	I3	5	7	8	4	I2	8	4	IO	4	4	9I
" with posterior staphyloma									I	I			2
Astigmatism, regular, . . .	I			2		I			2		2	3	II
" irregular, . . .			I		I	I							3
Total, ...	23	2I	II	I7	20	I6	2I	I7	I5	20	I6	I4	2II

XIII. AFFECTIONS OF THE ACCOMMODATIVE APPARATUS.

	January.	*Februrry.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Presbyopia, with E., . . .	I	6		I		I	I	2	3	3	2		20
" " M., . . .										I			I
" " H., . . .	4	I	2	2	4		I	I	I	2	I	2	2I
Asthenopia, ...	I						I	I	I			I	5
Paralysis and paresis of accom'd'n		3			I						I	2	7
Total, ...	6	IO	2	3	5	I	3	4	5	6	4	5	54

XIV. AFFECTIONS OF THE MUSCLES.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Paralysis, total of oculomotor nerve, ...		1	1		1	1	1	2		1	1	1	10
" partial, . . .											2		2
" of levator palpebræ,						1			1				2
" of levator palpebræ traumatic, .							1	1					2
" of levator palpebræ, congenital, . .					1	1		2					4
" of the 4th pair, .			1					1		1			3
" " " 6th " .	1		2		1	1						1	6
Squint, convergent with H., .	11	3	4	9	16	7	11	9	8	13	15	3	109
" " " M., .										1			1
" " periodic with H.	2		1	2	1		1	1	1	1			10
" divergent with M., .	1			2	1	1	1	1	1	1			9
" " " H., .	1												1
Insufficiency of internal recti,			2	1		1	1						5
Blepharospasm, ...	1				1	1	1		2		3		9
Total, ...	17	4	11	14	22	14	17	17	13	18	21	5	173

XV. AFFECTIONS OF THE FIFTH PAIR.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Circumorbital neuralgia, . .	1			1		1			1			1	5
Total, ...	1			1		1			1			1	5

XVI. AFFECTIONS OF THE LACHRYMAL APPARATUS.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Dacryo-cystitis, ...	4	1	2	4	7	4	4	8	1	4	2	1	42
Dacryo-cysto-blennorrhœa, .	1	1	2		2		1	1		1	1	1	11
Stricture of duct and sac, . .	2		1	3	6			1	1	1		2	17
Fistule, ...	1				1			1	1	1	1		6
Tumor, ...							1						1
Abscess of sac, ...		3	1		1	2	2	1			3		13
Total, ...	8	5	6	7	17	6	8	12	3	7	7	4	90

XVII. AFFECTIONS OF THE ORBIT.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November*	*December.*	*Total.*
Tumor, ...						1		1					2
Wound, ...				1									1
Periorbitis, ...			1		2	1			2	1	2		9
Caries, ...										1			1
Total, ...			1	1	2	2		1	2	2	2		13

XVIII. AFFECTIONS OF THE LIDS.

	January.	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Total.*
Erysipelas, ...										1			1
Emphysema, ...											1		1
Herpes, ...				1								1	2
Sudamina, ...						1							1
Variola, ...	1												1
Eczema, ...	2		1					1		1	2		7
Abscessus, ...	3		2		1	1	4	2			2		15
Blepharitis ciliaris, ...	9	19	18	9	8	8	17	9	11	9	10	15	142
Hordeolum, ...	2	3	2	4	5	2	2	3	2	2	5		32
Chalazion (tarsal tumors), .	7	5	3	4		2	4	1	1	1	3	2	33
Tumor (maligant), ...	2	1			2	1				2			8
Atheroma, ...					3				1				4
Ectropium, ...						2				1			3
Entropium, ...	4			1	3	1			1	3	2	1	16
Trichiasis, ...	1			2	2	1		2	1		2		11
Ecchymosis, ...	1								1				2
Wound, ...					1		1	1	1		1		5
Œdema, ...				1			2	2	1		1		7
Ulcer, ...			1										1
Epicanthus, ...					1								1
Blepharophimosis, ...						1							1
Phthiriasis, ...										1			1
Burn, ...					1		2					1	4
Total, ...	32	28	27	22	27	20	32	21	20	21	29	20	299
	299	285	340	333	380	353	331	338	313	342	309	250	

924 1,066 982 901

1.990 1,883

3,873

Table II. shows the sexes of the patients.

TABLE II.

	Male.	*Female.*	*Total.*
January, ...	139	160	299
February, ...	151	134	285
March, ...	168	172	340
April, ...	180	153	333
May, ...	215	165	380
June, ...	185	168	353
July, ...	181	150	331
August, ...	189	149	338
September, ...	173	140	313
October, ...	166	176	342
November, ...	158	151	309
December, ...	127	123	250
	2,032	1,841	3,873

Table III. shows how many of the male patients were children and how many adults. Those over 18 years were considered adults.

TABLE III.

	Children.	*Adults.*	*Total.*
January, ...	40	99	139
February, ...	47	104	151
March, ...	64	104	168
April, ...	61	119	180
May, ...	90	125	215
June, ...	67	118	185
July, ...	70	111	181
August, ...	73	116	189
September, ...	86	87	173
October, ...	59	107	166
November, ...	60	98	158
December, ...	51	76	127
	768	1,274	2,032

Table IV. gives the same account of the female patients.

TABLE IV.

	Children.	*Adults.*	*Total.*
January,	71	89	160
February,	58	76	134
March,	94	78	172
April,	66	87	153
May,	70	95	165
June,	80	88	168
July,	71	79	150
August,	58	91	149
September,	52	88	140
October,	79	97	176
November,	81	70	151
December,	52	71	123
	832	1,009	1,841

From table V. will be seen the relative frequency of the different diseases of the eye and its surroundings.

TABLE V.

	Total.	*Percentage.*
Conjunctiva (among these conjunctival catarrh in 50%, trachoma in 17%),	1,506	39
Cornea, (among these phlyctænular affections in 44%, in 10% of all diseases),	884	22
Sclera,	22	$\frac{1}{2}$
Iris,	149	$4\frac{1}{2}$
Choroid and ciliary body,	56	$1\frac{1}{3}$
Glaucoma,	39	1
Optic nerve and retina,	98	3
Amblyopia,	20	$\frac{1}{2}$
Lens,	187	5
Vitreous body,	26	$\frac{1}{2}$
Globe,	38	1
Refraction,	211	6
Accommodation,	54	$1\frac{1}{2}$
Muscles,	173	$4\frac{1}{2}$
Lachrymal apparatus,	90	$2\frac{1}{3}$
Orbit,	13	$\frac{1}{3}$
Lids,	299	$7\frac{1}{2}$
	3,873	100

II. CLINICAL REMARKS.

A. Affections of the Conjunctiva.

Catarrhal conjunctivitis was, as it is everywhere, the most frequent of the conjunctival affections. It was treated with nitrate of silver, when acute; with zinc and tannin, alum, etc., when chronic.

One-fourth of the cases coming under treatment were combined with blepharitis ciliaris. Since Dr. D. B. St. John Roosa, at the meeting of the International Ophthalmological Congress, held in New York in September, 1876, has advanced the idea that blepharitis ciliaris was, in about 83% of the cases, connected with ametropia and holds ametropia a frequent cause of conjunctivitis and blepharitis, 48 patients have been especially examined with regard to that statement. 39 of them had emmetropia, 5 myopia, 3 hyperopia, 1 astigmatism—certainly no striking prevalence of ametropia.

Blennorrhoic conjunctivitis was treated, in its beginning, with ice-applications, and as soon as the discharge became profuse, with 1% to 2% solutions of nitrate of silver. In three of the cases, during the treatment diphtheria developed. We were unable to trace the origin of the diphtheria to infection. Two of these cases recovered under careful treatment, in the third, that of a child, one eye was lost.

Two children were brought to the institution with phthisis of both eyes, the result of blennorrhœa. They came from a protectory of the neighborhood of New York, in which an epidemic of blennorrhœa had broken out.

Of the 34 children which came under treatment for *blennorrhœa of the new-born*, four showed, when seen for the first time, perforating ulcers of the cornea, causing the loss of four eyes. All the others recovered. The treatment consisted mainly in thorough cleansing of the lids, ice applications day and night, and application of nitrate of silver in a 1% or 2% solution.

The *trachoma patients* form the largest number for continuous treatment. The general features and complications of this dis-

ease did not reveal anything new; 6 of the cases were acute. Their treatment, during the first days, when great irritation was present, consisted only of cold applications. When the swelling, photophobia, and pain had subsided, the sulphate of copper stick was resorted to. This latter remedy was generally used in the chronic cases. Though certainly a number of patients suffering from this affection have been cured, the result of the dispensary treatment of many of these patients was unsatisfactory. They live in bad sanitary conditions, and discontinue treatment when they are so far improved as to be able to work and gain their living. Soon a relapse brings them back or leads them to some other hospital.

In several cases, after the granules had disappeared from the conjunctiva and lids, a dense pannus remained. The cornea in such cases was directly touched with the sulphate of copper crystal. This treatment is well borne and seemed to accelerate the clearing up of the cornea.

The youngest trachoma-patient was 3 years of age (lately we saw one 2½ years), which shows that children also are sometimes affected with trachoma.

Case I.—A little boy, E. L., æt. 4 years, had been treated two years previously for blennorrhœa. When he came under treatment again, his left upper lid was very much swollen and its inner surface presented a new-formation of tissue covered with a fibrinous exudation, which could easily be wiped off. The new-formation, which extended nearly over the whole area of the lid, corresponded in all its particulars to a papilloma. Its removal with the knife was followed by a profuse bleeding, which was stopped only by the application of a styptic fluid. The improvement, produced by the abscission, did, however, not last long. The new-formation rapidly grew again and a new abscission was followed by the same result. Nitrate of silver in substance was then resorted to. With this caustic the new-formation was several times totally destroyed, but always returned and finally appeared in the right eye in the same form. On microscopic examination of one of the pieces formerly cut off, the new-formation showed the conditions we find in trachomatous conjunctivæ. The treatment then was changed, and under careful cleansing and touching with sulphate of copper, the hypertrophy gradually decreased, and in about three months the lids were

cured. During the period of acute inflammation, both corneæ had burst, but recovered, with partial adherent leucoma.

A case of a very similar kind has recently been described in *Zehender's* Klin. Monatsbl., from the clinics of Vienna. Both of them show that chronic trachoma may lead to excessive hypertrophy and new-formation of tissue, so as entirely to conceal the primary cause. This teaches us not to hesitate in similar cases to make a microscopic examination before we undertake any treatment.

In five cases of trachoma, diphtheria suddenly developed, after a blennorrhoic stage of two or three days. In one case both eyes were affected; in the four others, one eye only.

Phlyctænular conjunctivitis was commonly treated with yellow oxide of mercury, applied in form of an ointment. When it was complicated with catarrhal conjunctivitis, the yellow salve and a one per cent solution of nitrate of silver were used.

Gonorrhoic conjunctivitis, which was not an unfrequent disease, was nearly always very severe. Three only of the twelve cases recovered without leaving serious consequences. In the beginning, ice-applications and the most careful cleansing were the only treatment; later, when the discharge became copious, 1 to 3 per cent solutions of nitrate of silver were used.

Case II.—K. G., æt. 39 years, presented herself with gonorrhoic conjunctivitis, a large ulcer at the upper half of the cornea. In spite of the treatment the ulcer increased, and finally led to a large perforation. The iris, protruding through the gap, was cut off, and the ulcer, which involved nearly the entire upper half of the cornea, gradually healed, leaving a large crescent-shaped leucoma, with a fairly round pupil, and $V = \frac{20}{50}$, at the time of the discharge of the patient.

Case III.—K. H., æt. 25 years, came under observation for gonorrhoic conjunctivitis three days after the infection. The lids were greatly swollen and hard; the discharge was very scant. While ice compresses were applied, a high fever set in, and the next day some diphtheritic patches appeared upon the conjunctiva, and on the outer surface of the upper lid, where the skin was sore. The cornea remained clear. When the diphtheritic membranes, which did not spread much farther, were

thrown off, a very copious blennorrhoic discharge appeared. In spite of the most careful cleansing, the cornea became hazy, and finally perforated near the lower margin. The patient was discharged with a leucoma extending over the lower two-thirds of the cornea.

Diphtheritic conjunctivitis was seen in twelve cases besides the four entered in Table I. These four cases came under treatment when diphtheria was already manifest. Several of the twelve other cases have been mentioned above. In all these cases the diphtheria of the conjunctiva occurred in eyes previously diseased. The four patients which presented themselves with manifest diphtheria, stated that for some time they had suffered from catarrhal conjunctivitis. Of the twelve other cases five occurred in eyes affected with chronic trachoma, three with blennorrhœa, one with gonorrhœa, one after enucleation, and in one instance diphtheria followed a simple squint-operation. In this latter patient, scarlatina broke out four days after the operation.

Save the case of scarlet-fever, no direct cause of infection could be traced, nor was diphtheria of the conjunctiva combined with the same affection of any other mucous membrane. All the cases were treated with ice-applications. Nitrate of silver was used only after the diphtheritic membranes were thrown off and the blennorrhoic stage had set in. No prophylactic bandage was applied to the unaffected eye, and the only disinfecting substance employed was a plenty of cold water. In all the cases coming under treatment, as long as one eye only was affected, the disease remained confined to this eye.

In three of the cases, in which both eyes were affected, one eye was entirely lost, whereas the others remained more or less useful. One of these eyes lost by diphtheria was recently enucleated on account of severe irido-cyclitis dolens.

In two of the five trachoma cases in which diphtheria occurred, the trachoma was (so far) cured by the latter disease; the remaining three were not so happy.

For *subconjunctival hemorrhage* no treatment was ordered. Its causes were very various: injury, cough, convulsions, etc.

The three cases of *symblepharon* were caused by burns with lime. Two of them were operated upon by transplantation of the dissected scar-tissue. One of these operations proved to be successful, while the other was followed by a relapse.

Of the five tumors of the conjunctiva, three were *granulomata*, one was considered to be a fibro-lipoma, and one a serous cyst. One of the granulomata was of a considerable size, measuring 10 mm. in breadth, 16 in length, and 4 in height. It occurred in the conjunctiva bulbi of a phthisical eyeball; otherwise it would probably have been removed at an earlier period.

The tumor which was considered to be a serous cyst, happened in a boy who had been slightly injured by the explosion of a fire-cracker. He stated that the cyst had originated in a little blood spot. It was cut off and the wound healed by moderate suppuration. On examination of the tumor I found it to be a small piece of transparent quartz encapsuled in connective tissue.

Of the three cases of *pterygium*, one was internal, one external, and one lay between the insertions of the external and inferior recti. Two cases were operated upon: one by double transplantation (Knapp's method), one by simple excision. Both operations were (so far) entirely successful.

From the microscopic conditions which I found in an eye affected with pterygium (see my contributions to the pathological anatomy of the eye in these ARCHIVES), I inferred that, as Arlt and others have stated, pterygium is always caused by a marginal ulcer of the cornea. The following clinical observations made during the past year changed my opinion and showed that a marginal ulcer is not the only cause.

Pterygium developed three times in eyes under treatment for a marginal ulcer of the cornea. Five times I observed its development in eyes without any ulcerative process in the cornea. In two of these cases it developed during an acute catarrhal conjunctivitis. One of the latter was exceedingly interesting. Pterygium internum had existed in both eyes for many years. With the acute conjunctivitis, new small pterygia corresponding to the insertions of all the other recti muscles

in both eyes made their appearance, more marked in the left, the more inflamed eye, than in the right. In the left eye they remained stationary, while the three new ones in the right eye disappeared under the treatment of the conjunctival catarrh.

Besides these eight cases, pterygia were seen three times in patients being treated for other diseases.

Lymphangiectasia was seen three times and presented the common picture. Once it lay near the upper, twice near the lower corneal margin.

B. Affections of the Cornea.

Phlyctænular keratitis was observed in 10% of all the patients, in 40% of the patients treated for affections of the cornea. The patients were mostly children. Ten were grown persons, the oldest being 65 years of age. In one case phlyctænular keratitis was combined with trachoma. Besides the treatment, consisting of atropine, yellow oxide of mercury, and a powder of ferrum reductum and rheum internally, great stress was laid on a regular diet, cold sponging of the entire body, much exercise in the open air, etc. When this could be accomplished, the patients soon became well. An excellent help in the treatment of this disease were the excursions on board the steamer which the St. John's Guild procured for poor children (floating hospital).

A large number of the patients treated for *parenchymatous keratitis* showed evident symptoms of hereditary or acquired syphilis. Notched teeth were seen very frequently. Many cases, however, were free from specific symptoms. Whilst the former cases always were treated with iodide of potassium, the latter received mostly a powder of ferrum reductum and rheum. These internal remedies, combined with atropine or vinum opii and warm applications, produced sometimes a comparatively quick and good result. Most of the cases, however, made a very slow recovery, others did not yield to any treatment.

What *Hirschberg* calls *keratitis postvariolosa* was seen in fourteen cases. The affection had no peculiar features. (V. Landesberg: Zur variolösen Ophthalmie.)

Nine cases of *corneal abscess* were treated by *keratotomy* according to Saemisch's method. In the others, Bowman's layer only, and the anterior lamellæ of the cornea were cut. Three of the former cases, which required daily reopening of the wound for nearly four weeks, healed with broad anterior synechiæ. Only one case of the whole number was combined with dacryo-cystitis, the majority were caused by injuries and foreign bodies.

Case IV.—L. T., æt. 16 y., had been operated on her left eye for divergent squint by advancement of the internal rectus. Soon after the operation the corresponding part of the corneal margin became infiltrated. Warm applications were not well borne and therefore replaced by cold ones. This treatment, however, combined with atropine, did not arrest the disease. An abscess formed and slowly extended toward the centre of the cornea. About two weeks after the operation, blood-vessels began to form and then the absorption took place. Though the healing was very protracted, it finally led to a good result.

None of the eyes affected with corneal abscess was lost.

The following case of *keratomalacia* is interesting as to its etiology.

Case V.—E. V., æt. 18 y., came to the institution for severe inflammation of his right eye. He stated that he sufferred first from diphtheria of the throat, and then from scarlet fever. During the latter sickness his right eye became inflamed and very painful, and he soon lost all sight in it. On examination there was found complete keratomalacia. There was no disease of the lids, no symptom of paralysis of the trigeminus, which might have been taken as a cause of this affection.

Among the cases of *corneal ulcers* the following should be reported.

Case VI.—T. B., æt. 36 y., came under observation for the said disease on the 26th of May. When first examined the following conditions were found. Right eye: A deep ulcer with infiltrated borders all around the corneal margin. Corneal epithelium hazy. Chemosis. Pupil dilated by atropine. Left eye: An ulcer of the same kind,

involving, however, only the lower inner third of the corneal margin. Patient has intense pain. He was then treated with atropine and warm water applications. May 27th. Some points of infiltration along the upper corneal margin in the left eye. The ulcer in the right cornea seems somewhat cleaner. May 28th. The points of infiltration in the left eye have coalesced into a yellow streak, running parallel to the upper corneal margin and extending into its outer third. Warm applications are no longer borne. Compressive bandage. May 29th. The yellow stripe of infiltration is now transformed into an ulcer with infiltrated margin and has joined the former ulcer. The ulcer in the right eye is clean. The sensibility of the right cornea is totally abolished, while in the left it is only diminished. This state remained nearly unchanged, till on June 9th blood-vessels appeared at the bottom of both of the ulcers. In left cornea a small perforation. June 10th. Left anterior chamber restored. June 11th. Left cornea again perforated. June 12th. Anterior chamber restored. The formation of vessels in both corneæ goes on rapidly, and the ulcers become smaller and healed up. When the patient was discharged, on June 28th, a marginal leucoma was forming in both eyes, without anterior synechia, and interfering little with his sight, since the centre was entirely clear. $V=\frac{20}{30}$ L. and $\frac{20}{40}$ R.

Out of the nineteen cases of *corneal staphyloma*, ten were operated upon; two by Küchler's, the remaining ones by Knapp's method. Four of the latter operations healed per primam, in two the wounds gaped again when the sutures were removed, and the formation of connective tissue over the prolapsed vitreous could nicely be observed. In two cases suppurative panophthalmitis set in after the operation.

Case VII.—St. J., æt. 24 y., a strong, healthy-looking young man, was operated upon for total staphyloma of the right cornea, with increase of intraocular pressure, on March 22d. As soon as the abscission had been made, the vitreous was suddenly thrown out of the eye, and a pulsating stream of blood made its appearance. Only after great efforts the bleeding was arrested, but returned every now and then during the next two days, until on the 25th purulent panophthalmitis set in. Patient stated that he always had been a hemophile.

Keratoconus was seen in three cases, twice affecting only one

eye. In two it was combined with old inflammatory changes of the cornea.

CASE VIII.—E. P., æt. 34 y., stated that for three years his vision was gradually impaired, and that he saw everything as through water. There was no trace of inflammation in the cornea, but very marked keratoconus, symmetrical in both eyes. The apex of the cone lay in the lower third of the cornea. $V=\frac{20}{70}$ L.; $\frac{20}{100}$ R. By —16 glasses vision was improved to $\frac{20}{40}$ L., $\frac{20}{30}$ R.

C. Affections of the Sclerotic.

Of the 14 cases of *episcleritis* only the following exhibited some interesting features.

CASE IX.—On August the 17th, R. R., æt. 10 y., was brought to the institute, after having suffered from an inflammation of his right eye for some weeks. The conditions were: Photophobia, lachrymation, some swelling of the upper lid, chemosis. At the outer third of the corneo-scleral margin the episcleral tissue was very much swollen and infiltrated. Aqueous humor turbid, iris somewhat discolored. Tn. Visual field complete. Diagnosis: Episcleritis. Treatment: Warm water applications, atropine, ferrum and rheum internally. While under treatment, the inflammation travelled all around the corneo-scleral margin, producing a very considerable swelling of the involved parts. This was the external condition of the eye, when on November 3d the patient complained of dimness of sight. Ophthalmoscopic examination revealed a central chorio-retinitis. The media were clear. Ord. iodide of potassium. Patient did not reappear until December the 4th, when he complained of not being able to see with this eye at all, though he was very much pleased with its external appearance. The conditions, then, were as follows: Very little swelling and injection of the episcleral tissue, the latter having a bluish tint. Anterior part of sclerotic somewhat ectatic. Some marginal opacities at the lower and inner part of cornea. Marked *neuro-retinitis.*

This was the last time the patient presented himself at the Institute. The case was exceptionally severe and this internal combination is certainly a rare occurrence.

The following case has been spoken of in my paper on "Sympathetic Ophthalmia" (V. v. 3 and 4, page 398). It

shows how, under certain circumstances, it may be very difficult to make a differential diagnosis between a beginning *scleral staphyloma* and an intraocular tumor.

CASE X.—A. B., æt. 30 years, presented himself on June the 5th. The following were the conditions of his left eye: Slight circumcorneal injection; corneal epithelium irregular, iris somewhat discolored; old posterior synechiæ; cataracta mollis, said to have come on gradually without any known cause. In the lower equatorial region a bluish-black elevation of the size of a large pin-head, which does not yield to pressure. V=0 and + T 1. Severe headache.

Since from the examination it remained doubtful whether this bluish-black elevation was a beginning scleral staphyloma, or a melano-sarcoma piercing the sclerotic, a small piece was cut off for microscopic examination. When the point of the knife touched the protrusion it collapsed and some vitreous escaped. Thus it was clear that we had to deal with a scleral staphyloma.

The eye had afterwards to be removed for sympathetic irritation of its fellow.

D. Affections of the Uveal Tract.

Iritis, as a genuine disease, was observed in 90 cases ($2\frac{2}{3}$ per cent), in ten of them affecting both eyes; one eye, however, more severely than the other.

In 26 cases ($28\frac{8}{9}$ per cent of all the cases of iritis) it was caused by general syphilis; in five of these, gummous tumors were present. The location of the gummata was three times in the minor iris circle and the pupillary edge, twice in the "angle of the iris." The specific iritis was treated with inunctions, combined with sublimate or calomel internally; besides atropine and leeches. All of the cases which entered the in-door department of the institute at an early stage of the disease were cured, whilst in such cases which refused to enter, the result was not always as desired.

CASE XI.—V. Gr., æt. 25 years, was admitted after having suffered from a severe inflammation of both eyes for about a week. He stated that he had been infected a year previously, and had been treated. There was severe iritis in both eyes and nearly total synechia. He was

leeched and mercurialized. Atropine was instilled every hour, and after some days nearly all the synechiæ yielded. After having been thus treated for nine days, a gummous tumor appeared in the lower angle of the iris of the left eye. Two days later, another was seen near the first. Each of them reached about the size of a pin-head, and decayed and was absorbed in six days, leaving hardly a trace. When the patient was discharged, all inflammation was gone. Vision in both eyes $\frac{20}{20}$.

Mercury was also given to patients suffering from non-syphilitic iritis and proved very beneficial.

Schnabel's statement "that he found in sixteen cases of specific iritis only one normal retina, and in ten cases of non-specific iritis only three"* could not but challenge a closer examination of all the cases coming under observation. I find in our records in three cases of iritis (two of which were specific), notes of an accompanying mild retinitis. In the twenty-four other cases examined especially as to this combination, retinitis was absent. The indistinctness of the outlines, and the dirty grayish appearance of the papilla, are not caused by retinitis. They are due to the turbidity of the aqueous humor and vitreous body.

The turbidity of the aqueous humor, which is hardly ever wanting in iritis, has not been taken in account by Schnabel. The turbidity of the vitreous body for him is characteristic of hyalitis, of which I have no doubt either. But he speaks of a genuine hyalitis, though he does not prove it. My own investigations, as well as those of *Schwalbe* and others, are fully convincing that a genuine hyalitis does not exist. *Berlin's* experiments on foreign bodies in the vitreous, as well as *Iwanoff's* observations on detachment of the vitreous body, do not prove the contrary, as long as it remains impossible to bring a foreign body into the vitreous without injuring at the same time any other membrane of the globe. In all the cases of hyalitis that I have examined, it was caused by an inflammatory process of the uveal tract.

Though, after all that has been mentioned, the possibility of

* The Accompanying and Consecutive Diseases of Iritis, by I. Schnabel. These ARCHIVES, vol. V. 2, page 169.

a combination of retinitis with iritis shall not be denied, I may state that, at least in the cases under our observation, it was of a rare occurrence, certainly nearly as rare as the cases of blindness following iritis, of which *Schnabel* seems to have seen an exceedingly large number.

Most of the cases, after the symptoms of iritis had disappeared, still showed some hyalitis, and were therefore kept under observation for some time longer. I do not know of one recent case in which the final result was not satisfactory. Blindness after iritis never occurred.

Sixty-one of the ninety cases of iritis occurred in male, twenty-nine in female patients. While the age of the male patients varied throughout (the oldest was 65 years), the greater part of the female patients that had non-specific iritis ranged between 44 and 58 years of age.

The *tumor* of the iris mentioned in table I. was a traumatic granuloma, and will be found in my "Contributions to the Path. Anat. of the Eye."

Uncommon *abnormities of pigmentation* of the iris were seen in two cases. In a boy, eight years of age, there were two small sectors of the iris entirely free from pigment. No signs of a former inflammation were present, and the eye was otherwise normal. In the second case, the lower half of the iris was nearly free from pigment. This condition was caused by iritis of long duration, and atrophy by the pressure of a dislocated chalky cataract. (Cf. Case 4, Vol. V. 3 and 4, page 401.)

In one instance in an aphakial blind eye (after division of a soft cataract), crystals of cholestearin were seen suspended in the aqueous humor, and in the parenchyma of the iris.

Serous choroiditis, or *detachment of the retina*, was observed in sixteen cases. Ten referred to male, six to female patients. Three of the cases were admitted to the hospital, two because they were very recent and offered some hope of improvement, the third was admitted more on account of the other eye, in which detachment seemed imminent.

Case XII.—W. S. E., æt. 20 y., when entering the Institute, stated

that he had always been very near-sighted. A week previously he first discovered that his right eye was nearly blind. There was divergent squint of about one line and a half. Size and mobility of the pupil normal. Visual field very much narrowed in the upper and lower peripheric parts. Media very dim. Venous hyperæmia. Counts fingers at the distance of two feet. The patient was kept in a dark room, lying as quiet as possible on his back, and Heurteloup's leech was applied every five or six days. Sublimate was given internally. After four weeks' treatment, during which the fundus gradually cleared up, there remained a small detachment of the retina in the lower periphery and some opacities in the vitreous body. He now counted fingers at fifteen feet and kept this vision as long as he was under observation.

Case XIII.—Mrs. O., æt. 42 y., entered the Institute after having noticed a gradual diminution of sight in her right, near-sighted, eye, which now had only perception of light. Her left eye was phthisical from a former disease. Patient was pregnant. Though the vitreous body of her right eye was very dim, a detachment of the lower half of the retina could easily be seen. After a fortnight's treatment, consisting in rest and applications of Heurteloup's leech, she wanted to be discharged, because she expected to be confined. The fundus then was nearly clear, a large detachment remained in the lower half of the retina. She counted fingers at seven feet.

There is one case of *coloboma of the iris* on record. The difformity existed in both eyes. While in the right eye it did not extend farther back than the insertion of the iris, in the left eye it involved the ciliary body, choroid, and optic nerve-entrance.

E. Glaucoma.

Nearly all the thirty-nine recorded cases of glaucoma were of the simple chronic kind. In ten of them both eyes were affected; one, however, more than the other. 23 cases occurred in male, 16 in female patients. 7 of all the patients were Jews. The youngest male patient was 29, the youngest female 23 years of age; the oldest male patient was 75 and the oldest female 76 years of age. 18 of these patients consented to be operated upon. 6 were operated upon both eyes, the whole number of iridectomies for glaucoma thus being 24.

In comparison with the conditions of the eyes before the operation, the results of the latter on the whole were satisfactory. Most of the cases were very old, the iris was atrophic and the healing was sometimes very protracted. In eleven eyes an after-hemorrhage occurred on the second or third day after the operation.

Four eyes only showed a marked improvement by the iridectomy. They are the following.

CASE XIV.—I. M., æt. 63 years. Diminution of sight for 6 years previous to operation. No headache or ciliary neuralgia. Right eye: only perception of light, which remained unchanged by the operation. Left eye: visual field wanting on the nasal and upper outer side. Only the inner lower quadrant well preserved. Disk whitish, punctate. Incipient excavation. Slight pressure produces arterial pulsation. + T 1. Counts fingers at two feet. One month after the operation: Visual field enlarged out and upward. No excavation, no pulsation on pressure. Counts fingers at fifteen feet.

CASE XV.—L. v. H., æt. 47 years. Diminution of sight in the right eye observed for eight weeks. Severe ciliary pain. Cornea and vitreous body very dim, deep excavation. + T 1. Faint perception of light. Visual field almost reduced to the point of fixation. Ten days after the iridectomy had been performed: visual field somewhat enlarged in all directions, least upward. Counts fingers at six feet. No pain.

CASE XVI.—A. M., æt. 54 years. Diminution of sight in the right eye observed for five months. Pain. Sees colored rings around the light, Vitreous body dim. Excavation. Visual field contracted nearly to the point of fixation. + T 1. Counts fingers at five feet. Three weeks after the operation: visual field very little enlarged. Counts fingers easily at twenty feet. No pain.

CASE XVII.—Br. H., æt. 65 years. Diminution of sight in right eye observed for eight months. Had been treated for six months with homœopathic medicines internally. Vitreous body very dim, so as to make it impossible to decide whether there existed an excavation or not. Visual field concentrically restricted toward point of fixation. Counts fingers at three feet. + T 1. Four months after the operation: vitreous much cleared. No excavation. Visual field very much enlarged. Vision=$\frac{20}{40}$.

Nine times slight iritis was observed after iridectomy for glaucoma.

One case was very remarkable for its protracted healing. It is the following.

Case XVIII.—Mrs. I. H., æt. 32 y., was operated upon her right eye for chronic glaucoma on January the 13th. After the corneo-scleral wound had closed and reopened several times, she finally was discharged four weeks after the operation, having retained the vision she had before the operation ($\frac{20}{70}$). On the 3d of March, while dancing, she felt a sudden pain in her eye and her sight at once became very dim. When she re-entered the Institute it was found that the corneo-scleral wound had been reopened. There was slight iritis. Wound and iritis healed again and she was discharged. On the 25th of May, however, she returned with a new attack of glaucoma in the same eye, and nearly total synechia. When she left the Institute this time, there were yet four small synechiæ; the intraocular pressure was normal. Her sight was now $\frac{20}{100}$. Though the wound since then has remained closed, and no new symptoms of iritis have appeared, she yet suffers from time to time from slight glaucomatous attacks.

In the case of *hemorrhagic glaucoma*, the first symptoms were large hemorrhages in the retina. After the patient had been treated for these during several weeks, glaucoma developed suddenly, ushered in by very severe pain. The operation relieved the pain, but the lost vision was not regained.

Consecutive glaucoma, occurring in the staphylomatous eye of a young seamstress, passed over, without any operation, by application of leeches and some days' rest in a dark room.

F. Affections of the Optic Nerve and Retina.

Affections of the optic nerve and retina were seen in 3% of the cases, rather a large number.

Neuro-retinitis was observed in nine cases without any assignable cause. Among the five patients who presented themselves with *hemorrhagic retinitis*, three suffered from diseases of the heart. In one of the remaining two the diagnosis had to be changed by the course the disease took afterwards. It is the following.

Case XIX.—W. L., æt. 19 y., came under observation on the 17th of April with a large retinal hemorrhage in the lower half of his right eye. He saw only movements of the hand. No cause for this trouble could be detected. No albumen in the urine. Iodide of potassium. Patient was seen about every fortnight and his sight improved to $\frac{10}{200}$. His urine was frequently examined, but showed no trace of albumen, until August the 30th, when he came with pronounced neuro-retinitis in his previously healthy left eye. Now, also, the general symptoms of Bright's disease made their appearance. Under treatment with ferrum tannicum also the conditions of this eye improved. The 20th of September patient complained of a new diminution of sight in his right eye, in which also we now found a pronounced neuro-retinitis. Though the conditions were improved somewhat a month later, the patient did not reappear.

This case is especially interesting on account of the space of four months intervening from the first hemorrhage in the retina and the appearance of the general symptoms of Bright's disease.

Neuro-retinitis Brightii was seen in eight other cases, which, on the whole, did not show many new features.

Case XX.—W. J., æt. 40 y., came under observation August 28th. His right eye had suddenly lost vision nearly a month previously. The ophthalmoscopic picture was somewhat unusual. Many striped hemorrhages in the retina. In the macula lutea a large oval patch, the upper half of which was formed by a very thin layer of blood, while the lower consisted of a dark coagulated substance. Horizontally nearly through the centre of the patch ran a white streak with a dark border on the lower side, as if casting a shadow. The streak appeared to be raised. Dr. Knapp, under whose care the patient was, pronounced it to be *coagulated fibrine*. This large blood patch was surrounded by a number of minute white patches. Albumen in the urine.

Case XXI.—A. Str., æt. 39 y., came under treatment for pronounced neuro-retinitis on the 5th of November. He suffered from intense headache. No albumen in the urine. The left temporal artery was atheromatous. Five weeks later albumen was found, and on the 18th of December patient died suddenly from Bright's disease, in the Mount Sinai Hospital.

Seven of the nine cases of *Bright's Neuro-retinitis* occurred in male patients, the youngest being 19 years of age; two in female patients, one being 22, the other 40 years of age.

Seven patients presented themselves suffering from *pigmentary retinitis.* Five were male, and severally 12, 42, 50, 52 and 53 years of age; two were female, one 7, one 10 years of age. Three of these cases did not show any complication; in two there was nystagmus, in one nystagmus and strabismus, in one posterior polar cataract. In one case only the disease had led into complete atrophy of both optic nerves and retinæ. Only in one case the parents were relatives.

One case of *embolism of the central retinal artery* was seen.

CASE XXII.—When T. M., 56 years of age, presented himself, he had been blind in his right eye for five days, after having been paralyzed in both legs four weeks previously. The blindness occurred suddenly after dinner. The retina was found to be very pale. The veins were dilated; only a small number of very thin arteries could be found. In the macula lutea was the characteristic red spot. The patient was seen only once, since he died from apoplexy shortly afterwards.

To the fifty-two cases of *atrophy* of the *optic nerve* we may fairly add fourteen of the cases recorded as *amblyopia*, the entire number thus being sixty-six. These cases, of course, exceedingly varied in degree.

As to their etiology, I compile the following statement from the records.

Atrophy after neuritis, 2.
from cerebral disease, 3.
from spinal disease, 2.
from abuse of liquors, etc., 14.
from syphilis, 11.
from injury, 4.
from lead-poisoning, 2.

In the remaining twenty-eight cases the cause was unknown.

Some further particulars about the cases of atrophy will be found in Table VI.

TABLE VI.—*A. Male.*

Cause.	*Color-blind for:*	*Vision, when first seen.*	*Age.*
1. Unknown, . . .	Red and blue.	R. $\frac{5}{200}$; L. $\frac{1}{200}$.	44
2. "	Red and yellow.	Both $\frac{10}{200}$.	18
3. "	———	R. $\frac{20}{100}$; L. $\frac{20}{40}$.	66
4. "	R. red.	R. $\frac{20}{200}$; L. $\frac{10}{200}$.	52
5. "	———	R. 0 ; L. $\frac{1}{\infty}$.	20
6. "	———	———	45
7. "	All colors.	Both $\frac{10}{200}$.	58
8. "	All colors.	Both $\frac{5}{200}$.	36
9. "	———	———	30
10. "	———	Both 0.	31
11. "	———	———	33
12. "	———	R. $\frac{20}{200}$; L. $\frac{20}{70}$.	59
13. "	———	———	53
14. "	———	———	49
15. "	Green.	R. $\frac{20}{200}$; L. $\frac{5}{200}$.	21
16. "	———	———	40
17. "	L. all colors, R. green.	R. $\frac{20}{100}$; L. $\frac{4}{200}$.	30
18. "	———	Both 0.	38
19. "	Red and green.	R. $\frac{20}{200}$; L. $\frac{20}{100}$.	47
20. Syphilis, . . .	Green and blue.	R. $\frac{8}{200}$; L. $\frac{10}{200}$.	32
21. "	———	R. $\frac{20}{30}$; L. $\frac{20}{200}$.	40
22. "	All colors.	Both $\frac{20}{200}$.	60
23. "	———	R. $\frac{20}{70}$; L. $\frac{10}{200}$	27
24. "	———	Both 0.	41
25. "	Red and green.	R. 0 ; L. $\frac{3}{200}$.	38
26. "	———	R. $\frac{14}{200}$; L. $\frac{1}{200}$.	58
27. "	———	R. $\frac{12}{200}$; L. $\frac{20}{50}$.	46
28. "	———	Both $\frac{1}{\infty}$.	36
29. "	All colors.	R. $\frac{7}{200}$; L. $\frac{2}{200}$.	30
30. Abuse, . . .	———	———	26
31. "	———	R. $\frac{20}{50}$; L. $\frac{20}{200}$;	34
32. "	Red and green.	R. $\frac{6}{200}$; L. $\frac{10}{200}$.	40
33. "	———	———	38
34. "	———	Both $\frac{20}{200}$.	52
35. "	———	R. $\frac{20}{40}$; L. $\frac{20}{70}$.	44
36. "	———	———	54
37. "	Green.	Both $\frac{7}{200}$.	45
38. "	———	R. $\frac{20}{40}$; L. $\frac{20}{100}$.	30
39. Cerebral, . . .	———	R. $\frac{20}{20}$; L. $\frac{20}{100}$.	49
40. Injury, . . .	———	R. $\frac{1}{\infty}$; L. $\frac{20}{20}$.	46
41. "	———	R. $\frac{20}{20}$; $\frac{20}{200}$.	43
42. "	Red.	R. $\frac{10}{200}$; L. $\frac{20}{20}$.	64
43. Spinal, . . .	Blue.	R. $\frac{20}{50}$; L. $\frac{20}{70}$.	53
44. "	All colors.	R. $\frac{1}{\infty}$; L. $\frac{20}{100}$.	48
45. Neuritis, . . .	———	R. $\frac{1}{\infty}$; L. 0.	63
46. Lead-poisoning . .	———	Both 0.	32
47. " " . .	———	R. $\frac{1}{\infty}$; L. $\frac{1}{200}$.	44

B. Female.

Cause.	*Color-blind for:*	*Vision, when first seen.*	*Age.*
48. Unknown, . . .	——	——	29
49. " . . .	——	——	45
50. " . . .	——	Both o.	14
51. " . . .	——	R. $\frac{20}{200}$; L. $\frac{1}{200}$.	40
52. " . . .	——	R. $\frac{4}{200}$; L. $\frac{20}{100}$.	50
53. " . . .	All colors.	R. $\frac{20}{70}$; L. $\frac{4}{200}$.	40
54. " . . .	——	R. $\frac{10}{200}$; L. $\frac{20}{50}$.	35
55. " . . .	Red.	R. $\frac{20}{70}$; L. $\frac{7}{200}$.	66
56. " . . .	——	R. $\frac{3}{200}$; L. $\frac{20}{70}$.	33
57. Syphilis, . . .	——	——	30
58. Abusus, . . .	——	Both $\frac{20}{50}$.	40
59. " . . .	Green.	Both $\frac{20}{200}$.	46
60. " . . .	Red and green.	R. $\frac{10}{200}$; L. $\frac{15}{200}$.	35
61. " . . .	Blue.	Both $\frac{10}{200}$.	18
62. " . . .	——	R. $\frac{20}{200}$; L. $\frac{20}{100}$.	57
63. Cerebral, . . .	——	R. $\frac{20}{70}$; L. $\frac{20}{20}$.	30
64. "	Green.	R. $\frac{20}{200}$; L. $\frac{15}{200}$.	50
65. Injury, . . .	——	R. o; L. $\frac{20}{20}$.	$8\frac{1}{2}$
66. Neuritis, . . .	——	——	5

From the foregoing table it will be seen that atrophy of the optic nerve occurred in 47 male and 19 female patients, the youngest being five, the oldest sixty-six years of age.

Color blindness was noticed in twenty-two of the cases; in six of them no color at all could be perceived. The various cases of color blindness show that the different theories advanced to explain this defect do not in all particulars agree with nature. It is to be hoped that the recent discoveries of *Boll*, *Kühne*, and others will soon lead to more satisfactory theories on the perception of colors.

In six cases the atrophy affected at the time the optic nerve of only one eye, its cause being twice cerebal, four times traumatic.

Glioma was seen in two cases, affected both eyes, and was too far advanced to justify an operation.

Opaque nervous fibres of the retina were in two cases the cause of complaint; hyperæsthesia of the retina and asthenopic symptoms. They were observed in three other cases being under treatment for other diseases. All the five patients were in females. The ophthalmoscopic picture was as usual.

One case of *left-sided binocular hemiopia* occurred in a woman 39 years of age, during an apoplectic seizure on the ninth day after confinement.

G. Affections of the Crystalline Lens.

Affections of the lens appeared in 5% of all the cases. Their different forms may be seen in Table I.

In the 75 cases of *mature senile* cataract in one eye, there existed at the same time 38 times an immature cataract in the fellow-eye. In 43 of the 50 cases of *immature progressive* cataract the affection was present in both eyes. 9 of the 11 cases of *hypermature* cataract were combined with immature cataract of the other eye, in one case the other eye was free, and in one it had a mature cataract.

Senile cataract was thus observed in 209 eyes; 121 times in the right, 88 times in the left.

Of the 118 patients in which senile cataract occurred, 66 were males, 52 females.

The result of the extractions of cataract may be seen in Dr. Knapp's report, as far as his own operations are concerned. (See this volume, first paper.)

The cases of *traumatic cataract* and *dislocation of the lens* will be spoken of under the head of "Injuries and Sympathetic Ophthalmia."

Posterior polar cataract was observed five times, always in myopic eyes.

Division for *soft cataract* was made in four eyes; in one it was made twice. This latter also was the only one showing some reaction after this operation.

Case XXIII.—A. M., æt. 18 y., was operated on her left eye on the 5th of June. During the night following the operation she suffered from severe pain. The next morning the pupil was narrow, the lens-substance very much swollen and bulging into the anterior chamber. Some increase of intraocular pressure. After six leeches had been applied to the temple and atropine was instilled every half-hour, she was soon relieved. A second division of the shrunken lens was made on the 19th of July, without being followed by any reaction. The lens now is

entirely absorbed and only a very fine string of lens capsule runs across the pupil. Sight excellent.

H. Injuries to the Eye and their Consequences, including Sympathetic Ophthalmia.

One hundred and nine cases of injuries to the eye came under observation, excluding all the minor injuries to the surface of the cornea and conjunctiva, and burns by caustics.

They are the following:

1. Large corneal ulcer, 2.
2. Kerato-iritis, 5.
3. Corneal wound with prolapse of iris, 14.
4. " " " irido-dialysis, 2.
5. " " " irido-cyclitis, 3.
6. " " " prolapse of ciliary body, 1.
7. " " " chronic irido-choroiditis, 7.
8. " " " purulent iritis, 1.
9. " " " purulent irido-choroiditis, 5.
10. " " " cataract and prolapse, 3.
11. " " " " " irido-dialysis, 1.
12. Wound of cornea and sclera, 4.
13. Wound of cornea and lens, 15.
14. Wound of the sclerotic, 3.
15. Wound of the sclerotic, with iritis, 1.
16. Hæmophthalmus, 1.
17. Cataracta mollis and rupture of zonula, 1.
18. Staphyloma, 4.
19. Foreign body in eye without present inflammation, 5.
20. Dislocation of lens, 8.
21. Rupture of choroid, 2.
22. Retinal hemorrhage, 1.
23. Atrophy of optic nerve, 4.
24. Phthisis bulbi, 16.

Total, 109.

Of these 109 cases, 33 occurred in children. In all the cases of corneal wound with prolapse, the prolapse at once was cut

off with favorable results. Of the *traumatic cataracts* 6 were operated on.

They are the following:

Case XXIV.—S. D., æt. 48 years, was struck in his left eye with scissors. Cataract extracted by Von Graefe's method, downward. While completing the section the iris was freed from its anterior synechia. Final result, V $\frac{20}{40}$.

Case XXV.—Chr. M., æt. 20 years, was injured on his left eye by a small piece of steel. Section performed with a lance-shaped knife, down and inward, and carried through the anterior synechia Lens came out only partially. Subsequent iritis and absorption of the swollen lens-substance. When discharged, counted fingers at eight feet.

Case XXVI.—A. F., æt. 10 years. Anterior synechia of iris and lens-capsule, traumatic cataract in the left eye. Section with Von Graefe's knife carried through the synechia. Most of the lens came out. Subsequent iritis, new anterior synechia. Three weeks later division of secondary cataract. Final result, V $\frac{20}{30}$.

Case XXVII.—D. G., æt. 12 years. Traumatic cataract and anterior synechia in the right eye. Section with Von Graefe's knife carried through the attached iris. Some lens-substance remained in the eye and was absorbed later. Final result after secondary operation, V $\frac{20}{20}$.

Case XXVIII.—B. D., æt. 37 years. Traumatic cataract and posterior synechiæ in the right eye. Von Graefe's section upward. After some of the lens-substance was removed, the vitreous body presented in the wound, without escaping, however. The remaining lens-substance was gradually absorbed. Patient seeing through a small clear central pupil had V $\frac{20}{200}$. After operation for secondary cataract, V$=\frac{20}{70}$ (April, 1877).

Case XXIX.—K. H., æt. 76 years. The traumatic cataract in the left eye was half dislocated into the anterior chamber. Corneal flap. No iridectomy. Final result, V $\frac{20}{40}$.

In two of the cases of traumatic cataract the absorption of the lens-substance took place without an operation. One of these patients, injured by a thistle, has now V ^{20}.

Five of the eyes which were phthisical after having been injured were removed, lest they might one day give rise to sympathetic affections.

In three out of the eight cases of *traumatic dislocation of the lens*, the displacement was into the vitreous body; in one, half into the vitreous and one-half into the anterior chamber; in three, into the anterior chamber; in one, the lens was first dislocated into the vitreous body and afterwards fell into the anterior chamber. Two of the lenses dislocated into the anterior chamber were extracted. They are the following:

Case XXX.—G. G., æt. 32 years, received a heavy blow on his right eye, which caused laceration of both lids. Only after the lids had healed, he presented himself at the Institute. The transparent lens then lay in the anterior chamber and had caused a considerable increase of intraocular pressure. He saw only movements of the hand. Von Graefe's knife was thrust through the lens and the lens extracted in completing the section. Some vitreous body escaped. The prolapse of the vitreous body and some remnants of the lens caused a very protracted recovery. When discharged he counted fingers at three feet. Not long afterward, however, the patient was obliged to come back on account of severe pain in his eye. There was a partial staphyloma at the site of the corneo-scleral scar, and new increase of tension. His vision was now reduced to perception of light. Abscission of the staphylomatous scar removed the irritation.

Case XXXI.—G. W., æt. 65 years. When the patient presented herself, the cataractous lens lay in the anterior chamber, and there was some increase of tension. The section was made upward and followed by the spontaneous expulsion of the lens. The iris prolapsed some days after the operation when, by an accident, the wound was reopened. Final result: V $\frac{6}{200}$.

The following is the history of the case above mentioned, in which the lens was dislocated partially into the anterior chamber, and partially into the vitreous body.

Case XXXII.—M. B., æt. 24 years, was struck on her right eye by the cork of a soda-water bottle a week before she entered the Institute. There was some increase of intraocular pressure. To relieve the patient from her pain, Dr. Gruening performed paracentesis of the anterior chamber, with a lance-shaped knife. The prolapsing iris was cut off. The paracentesis of the anterior chamber had to be twice repeated.

The lens lay finally in its normal position and the patient so far is doing well.

Isolated *rupture of the choroid* was seen in the following two cases.

Case XXXIII.—Fr. C., æt. 27 years, had been struck by a base-ball on his left eye, six months previous to examination. From that time he could not see well on account of a black streak crossing every object he looked at. The ophthalmoscope revealed a long rupture of the choroid on the outer side of the macula lutea, running concentrically to the outline of the optic nerve. The upper end of the rupture divided into three smaller branches. His vision was $\frac{20}{20}$.

Case XXXIV.—G. S., æt. 26 years. A week previous to examination he had received a heavy blow against his right eye. When he was first seen, the vitreous body was so dim and full of opacities that a clear view of the fundus could not be obtained. A week later, a long rupture of the choroid could be seen in its lower half. It ran concentrically to the margin of the optic nerve, its centre being about two disk-diameters below the macula lutea.

In both these cases some of the larger veins of the choroid passed uninjured over the defect.

Sympathetic affections were obtained in the following 18 cases.

A. Sympathetic Irritation.

1. Case XXXV.—A. B., æt. 30 years. (This case has already been reported under No. 2 in my paper "On the Anatom. Causes, etc., of Symp. Ophth.," Vol. V. 3 and 4, page 398; and under Case XI. in this paper.) There was a small black protrusion in the lower equatorial part of the left eye, the nature of which was somewhat doubtful It was thought either to be a beginning staphyloma or an intraocular tumor. The attempt to take a little piece off for microscopic examination showed it to be a staphyloma. Four days after this puncture sympathetic irritation of the right eye was caused by a new inflammatory attack in the left. The left eye was then enucleated and the patient relieved of all symptoms in the right.

2. Case XXXVI.—P. B., æt. 45 years. (This case has been reported in the same paper under No. 3.) The right eye had been struck by a splinter of iron, three weeks previous to the first examination. The

diagnosis was: foreign body in the right eye; irido-cyclitis dolens. Sympathetic irritation in the left eye. The enucleation of the right eye was consented to only a week later, when the symptoms of sympathetic irritation were very much increased. The enucleation of the right cured the left eye entirely.

3. Case XXXVII.—T. W., æt. 46 years, had been struck by a piece of glass into his left eye, five weeks previous to his first presentation at the Institute. The conditions then were: some circumcorneal injection, pigmented scar in the lower corneo-scleral region extending downward to the equator. Iris adherent to the scar. Anterior chamber shallow, pupil wide. —T2. Perception of light. Inner and lower half of visual field wanting. Fundus cannot be illuminated. (Detachment of retina?) Sympathetic irritation in the right eye, which was at once relieved by the enucleation of the left.

4. Case XXXVIII.—C. S., æt. 36 years. When a child, the patient had been struck on her left eye. Since that time the eye gradually enlarged, inflamed from time to time, causing severe pain. When first examined at the Institute, the eye had the form of what is called hydrophthalmus. Especially the cornea and anterior chamber were very large. There was circumcorneal injection and a central speck in the cornea. Aqueous humor turbid. Iris somewhat discolored. Lens tremulous. Tn. Perception of light. Patient stated as the only symptom in her right eye, that its vision had been failing for some time. Two weeks after this examination a new inflammatory attack made the left eye greatly worse, necessitating its enucleation.

5. Case XXXIX.—Fr. Br., æt. 22 years. (This case has been spoken of under No. 1 in the paper above mentioned.) Six weeks before the patient came under observation, his left eye had been injured by a piece of steel. Since that time it had continued to be inflamed and painful. When he was first seen, there was a scleral scar in the lower ciliary region. Considerable chemosis. Iritis. A yellow reflex from the pupil. Patient then was kept under observation for some days, during which a spongy exudation developed in the anterior chamber. Sympathetic irritation being now well pronounced in the right eye, the left eye was enucleated. This operation relieved all the symptoms in the right eye.

6. Case XL.—C. V., æt. 44 years, had been struck on his right eye twelve years previously. Since that time he had in it frequent inflammatory attacks, accompanied by severe pain. There was a corneo-scleral scar. The globe very much shrunken. Recent inflammation.

Ossification of the choroid. Sympathetic irritation of the left eye, which was fully relieved by the enucleation of the right.

7. Case XLI.—T. B., æt. 56 years, had been injured by a piece of stone on his left eye, ten years previously. The ensuing inflammation had lasted for many months. Later on he had frequent inflammatory and painful attacks in this eye, in which the right always participated. Four weeks previous to examination, such an attack had suddenly come on and changed the appearance of his left eye. The left eye was staphylomatous. There was hæmophthalmus and the sight totally abolished. + T 2. Marked symptoms of sympathetic irritation in the right eye, which disappeared entirely after the left was enucleated.

All of these seven cases show the good therapeutic effect of the enucleation of the eye first injured, as long as the sympathetic affection has not yet caused anatomical changes in the membranes of the fellow-eye. I think this fact, in comparison with the poor results of the operation in later stages, should remove all hesitation concerning the enucleation of an eye which is both useless and dangerous. There is no doubt that many an eye has been taken out for imaginary sympathetic trouble, yet it is certainly better for the patient to lose an eye, liable at any time to give rise to sympathetic affection, than by keeping it to be exposed to total blindness. This, of course, is different when the patient can remain under observation, and has some sight left in the injured eye.

B. Sympathetic Iritis.

8. Case XLII.—B. St., æt. 64 years, was operated on four months previously for cataract in her right eye, by Von Graefe's method, in one of our neighboring cities. Purulent panophthalmitis and phthisis bulbi had been the unfortunate result. For four weeks previous to examination, she noticed symptoms of sympathetic irritation in her left eye. Now severe iritis sympathetica was present. The patient was sent back to the operator.

9. Case XLIII.—W. G., æt. 5 years, had been hurt in his right eye by a pair of scissors, five months previous to examination. There was a scleral scar in the upper equatorical region. The globe was phthisical

and there recent cyclitis dolens was present. Sympathetic iritis in the left eye. Enucleation of the right advised, but refused by the mother.

10. CASE XLIV.—Ch. D., æt. 60 (?) years, was operated on by Dr. Knapp, for cataract in his right eye, October the 20th. The cataract was of many years' duration and the cortical substance not yet completely opaque. The operation was followed by purulent irido-choroiditis. There had been sometimes a slight conjunctival redness in his left eye, and disappeared again, when at once, on the 18th of December, eight weeks after the operation, without any warning symptoms, iritis appeared in this left eye. The right then was at once enucleated. Since this unfortunate case will be described more extensively by Dr. Knapp, I will only add that the sympathetic affection took a slow course, caused great pain, and led to blindness.

C. Sympathetic Irido-cyclitis.

11. CASE XLV.—Ch. B., æt. 9 years. (This case has been spoken of under No. 20, vol. V. 3 and 4, page 433, in the paper above mentioned. Though it is there entered under the cases of iritis, because the patient came first with this affection, it should be named under the cases of irido-cyclitis.) His left eye had been injured by a pin seven years previously. When he was first seen there was chronic irido-choroiditis in the left eye and slight sympathetic iritis in the right. The enucleation of the left eye removed all symptoms of the right so quickly that he could be discharged five days after the operation. Two weeks afterwards patient came back with plastic irido-cyclitis. His vision was then $\frac{2}{200}$. The inflammatory symptoms subsided under mercurial treatment. The attempt to make an iridectomy proved unsuccessful and in few days the coloboma was closed again. When he was discharged he had regained a vision of $\frac{20}{200}$. Since that time his sight has changed several times, it was once reduced to $\frac{10}{200}$, but is now again $\frac{20}{200}$. The anterior chamber is very shallow, more than half of the pupil is filled with a pseudo-membrane.

12. CASE XLVI.—C. S., æt. 58 years, had been struck by a piece of iron on his right eye, eighteen years previously. An operation had then been performed on that eye and the foreign body was extracted. Soon after this operation, which proved unfortunate, his left eye became inflamed and he almost lost his sight. When examined, there was occlusion of the pupil in the right blind eye, and the iris was drawn into a scar in the upper corneo-scleral margin. In the left eye also there was

occlusion of the pupil, which was almost complete. Perception of light good. Tn. After instillation of atropine, counts fingers at two feet. No sign of any present inflammation. An upward iridectomy raised V to $\frac{15}{200}$.

13. CASE XLVII.—A. B., æt. 48 years. Left eye struck by a piece of a gun-cap three years previously. Severe inflammation. Five weeks afterwards the right eye began to be painful, and there was great photophobia, and lachrymation, and impairment of sight. The inflammation in the right eye lasted for eight weeks, then sight was reduced to mere perception of light. There has been no other inflammatory attack. Eighteen months after the injury of the left eye, which had continued inflamed, the piece of gun-cap pierced the sclerotic and was removed with a pair of forceps. When examined there was complete phthisis of the left eye, and in the right a dense pupillary membrane. The periphery of the iris was raised in the shape of a ring. Some circumcorneal injection. Perception of light good. Visual field complete. Tn. A large iridectomy was then performed on that eye; the pupil, however, closed again in three days.

14. CASE XLVIII.—T. K., æt. 59 years. Two years previously, kerato-iritis in right eye from burn with lime. Sight lost. Four months later, the left eye began to be inflamed: great pain, photophobia, and lachrymation, vision rapidly failing. When first examined, the anterior chamber of the right eye was very shallow, and there was a dense pupillary membrane and a crater-shaped iris. Vision 0. Tn. Circular synechia in the left eye, leaving free a very small part of the upper pupillary edge. Tn. Visual field complete, $V=\frac{2}{200}$, after instillation of atropine, $\frac{4}{200}$. Since patient complained of excessive pain in his right (blind) eye, it was enucleated. Some weeks later an upward iridectomy in his left eye gave him vision $\frac{9}{200}$.

D. Sympathetic Irido-choroiditis.

15. CASE XLIX.—A. C., æt. 32 years. Right eye injured three years previously. Five weeks later, the left eye became inflamed and the right was removed without producing any improvement in the left, which gradually lost its sight. When first examined there was in the left eye a very shallow anterior chamber. A pupillary membrane all around the edge of the iris left a small central space free, through which a red reflex could be obtained. No present inflammation.

Perception of light and projection good in the upper half of the visual field. The lower half entirely wanting. —T 1.

16. Case L.—G. H., æt. 14 years. This case has been spoken of in the paper above mentioned under No. 24, Vol. v. 3 and 4, page 443. When the patient was first seen, his right eye had been injured by a piece of stone six weeks previously. There was cyclitis dolens. Since there was at the same time marked sympathetic irritation in the left eye, the enucleation of the right eye was advised, but not allowed until a week later, when there was severe iritis in the left eye and vision diminished to $\frac{5}{200}$. After the enucleation the conditions of the right eye were improved for a short while. When he was seen later, sympathetic irido-choroiditis was manifest. After all inflammatory symptoms in the eye had ceased, it was attempted to make an iridectomy upward. The degenerated iris, however, did not give way, but was torn by each grasp with the forceps.

E. Sympathetic Neuro-retinitis.

These two cases will be found fully described in my paper, "On Sympathetic Neuro-retinitis," read before the international congress of ophthalmology, held in New York, Sept., 1876. (See Report Cases VI. and VII.)

17. Case LI.—T. L., æt. 11 years. Six weeks previous to examination a gun-cap penetrated into the right eye, and was removed two days later. From that time this eye had been inflamed, and a week ago the left eye showed the first signs of sympathetic trouble. When examined, there was in the right an elevated scar at the outer-lower corneo-scleral margin, in which iris was imbedded. Iritis. $V = \frac{2}{200}$. Tn. Visual field complete. In the left eye, small posterior synechiæ all around the pupil. Pronounced venous hyperæmia of the papilla and retina, the disc and its surroundings grayish infiltrated; neuro-retinitis. $V = \frac{4}{200}$. Tn. Visual field complete. After the prolapse in the right eye was cut off, there was a temporary amelioration. Very soon, however, irido-choroiditis developed in the left eye and did not allow to trace the progress of the neuro-retinitis. Later a sudden attack of glaucoma in this eye produced staphyloma, perforation in the upper part, and escape of pus. Total blindness and phthisis in both eyes was the final result.

18. Case LII.—W. H., æt. 38 years, lost his right eye twelve years previously by a disease, which was probably glaucoma. Ever since,

he had frequent attacks of inflammation and pain in this eye. When examined, his right eye was in the condition of total staphyloma and blind. For six days the sight in his left eye had been rapidly failing. There was no external change, and the patient saw only movements of the hand. The ophthalmoscope showed the conditions of diffuse neuro-retinitis: whitish infiltration reaching nearly over the whole area of the retina and some striped hemorrhages. The media were entirely clear. No combination with any disease of the uveal tract. Enucleation of the right eye. Three days after it, a large hemorrhage took place just in the macula lutea and a smaller one on the nasal side. Then rapid improvement. A week after the enucleation the outer margin of the papilla was again sharply defined. Four weeks after the operation the infiltration was nearly totally absorbed and his vison $= \frac{20}{30}$. This condition has remained unchanged since that time, though the disc, now, looks rather whitish. During the affection the urine was examined several times, but found normal.

I. Refraction and Accommodation.

Of 104 patients with myopia, 54 had marked sclero-choroiditis posterior. The highest degree of myopia observed during the year was M $1/1\frac{1}{2}$ in a girl 13 years of age. M $\frac{1}{2}$ was seen in a school teacher 30 years of age, who stated that for the past fifteen years his nearsightedness had gradually grown worse. His vision was R. $= \frac{20}{200}$ and L. $\frac{15}{200}$. Besides a very large staphyloma posticum in either eye, there was disseminate choroiditis in the right and a recent hemorrhage in the macula lutea of his left eye.

Adding to these 104 cases, having come under observation especially for their myopia, the cases of detachment of the retina in myopic eyes, of posterior polar cataract, of presbyopia with M, of insufficiency of the internal recti muscles and those of divergent squint, we get 133 cases of myopia.

Hyperopia, 93 patients. The highest degree was H $\frac{1}{5}$.

Adding to these the cases recorded under presbyopia with H, and those under convergent squint, we find 234 cases of hyperopia. This number would be larger yet, if the refraction of the eyes with glaucoma had been recorded.

Among the seven cases of *paralysis of accommodation* without other complications, two were caused by diphtheria, two by syphilis and one by an injury. Some of the patients wore convex glasses for reading, all of them recovered.

K. Affections of the Muscles.

Strabismus not caused by paralysis or any other causes but refraction was seen in 130 cases. They were:

Manifest convergent squint with H	109.
Manifest convergent squint with M	1.
Periodic convergent squint with H	10.
Manifest divergent squint with M	9.
Manifest divergent squint with H	1.
	130

Of these cases 89 were operated upon by the subcutaneous tenotomy. In 11 of the cases the effect of the tenotomy was increased by a suture. 21 cases required a second operation on the other eye. All the cases but one were successful. In this latter, the eye operated upon was lost by diphtheria. It is mentioned above under conjunctival diseases.

L. Affections of the Lachrymal Organs.

Strictures of the duct and sac were always treated by injections and probing. Catarrh of the nose was never lost sight of. The upper canaliculus was slit as a rule. When the patient came regularly and long enough the results were satisfactory. Several times it was necessary to open the sac freely by slitting its temporal wall.

In children and in cases of caries, where ozœna was very marked, the treatment resorted to were injections of warm water and a five-grain solution of nitrate of silver into the naso-pharyngeal cavities. Great care was taken not to inject more nitrate of silver than a few drops.

In all of the cases of *lachrymal abscess* a free incision was made as soon as the patient came under observation, thus saving him the fearful pain which almost always is connected with this affection.

M. Affections of the Orbit.

Of all the cases of the affections of the orbit only the following three deserve to be mentioned. They have been fully described in a paper of Dr. H. Knapp's, read before the international congress of ophthalmology, "On Orbital Tumors." (V. Transactions.)

CASE LIII.—Mr. A., æt. 36 years. When examined, a hard bony tumor the size of a small apple was found situated upon the bridge of the nose and extending into each orbit. For seven years the tumor had been slowly growing. It was removed by hammer and chisel and and proved to be an ivory-exostosis. The recovery was very smooth and the disfigurement very little.

CASE LIV.—A. S., æt. 56 years. Patient had been operated upon for nasal polypus 16 times by extraction. For ten months previous to examination he had perceived a swelling of the region of the antrum Highmori and exophthalmus on the left side. The orbital tumor could be felt as a soft roundish substance at the inner wall. The eye was pushed forward and outward and downward. The tumor was carefully removed. It filled the orbit and all the neighboring cavities The eye and the optic nerve were preserved. The wound healed without any severe reaction, patient saw well and moved the eye tolerably well, there being only some loss of motility inward and upward. Microscopical examination showed the tumor to be a myo-carcinoma.

CASE LV.—P. H., æt. 29 years, had been operated upon by Dr. H. B. Sands, two years previously, for enchondroma of the antrum Highmori on his left side. When he came for a new examination, there was considerable exophthalmus on the same side, and a soft tumor could be felt in the orbit upward and inward. The tumor intruded into the neighboring cavities and was cleanly removed by Dr. Sands, without an injury to the eye. The wound healed well, but some exophthalmus remained. Soon after the patient was discharged, he came back on account of severe headache, and blindness of his left eye. He then had atrophy of the left optic nerve and neuro-retinitis in the right eye. The exophthalmus grew larger, and patient was transferred to the Roosevelt Hospital in this city, where I saw him some time ago. His general condition was a great deal worse; he

suffered constantly from intense headache, his mind was troubled and he was totally blind. There was now also beginning atrophy of the optic nerve in his right eye. The exophthalmus of the left was considerably increased. Microscopic examination showed the tumor to be an enchondroma myxomatodes.

N. Affections of the Lids.

Of the affections of the skin of the lids, the following two case may be of some interest.

Case LVI.—M. M., 60 years of age, came to the institute for an eruption on her cheeks and eyelids. She stated that for many years during the summer-heat she had the same eruption, and that it lasted generally during the hot days. There was a great number of small vesicles, filled with a colorless fluid, confined to the orifices of the sudoriferous glands. Some of them were surrounded by a zone of inflammation. No disagreeable sensation was present. Diagnosis: *Sudamina.*

Case LVII.—M. P., æt. 10 years, had been treated for small-pox, and left the small-pox hospital a week previous to an eruption on the left eye, for which she applied to the institute. There were two small ulcers at the ciliary edge of the upper lid, and a larger one at the lower lids. Next to this latter, there was a pustule with a central depression. Patient stated that where the ulcers now were, there pustules had been before. Diagnosis: *Variola* of the lids. The interesting point is that this eruption on the lids happened a week after the patient had been discharged from the hospital, as being cured.

Emphysema of the lids was seen in one instance.

Case LVIII.—W. H., æt. 20 years, had received a heavy blow on his right eye, the day before he presented himself. There was marked exophthalmus, and swelling of the upper lid, which could not be fully raised. No inflammatory symptom was present, no diplopia. On palpation, the crepitus characteristic of emphysema was easily felt. Probably the os planum was fractured.

To the 142 cases entered under *Blepharitis ciliaris* we have to add those complicated with conjunctivitis (134), making the whole number 276 cases. Of the refractive conditions of a

number of these cases, examined especially for that purpose, I have spoken under A. The treatment consisted in thorough cleansing, yellow oxide of mercury and nitrate of silver in ten and fifteen grain solutions. All the patients who, or whose parents followed the treatment regularly, were cured.

Whilst only 16 cases of entropium are found in Table I., 22 cases (some of them were entered in previous years) were operated upon, and all but one successfully. The method was always the excision of a wedge-shaped piece of the tarsal tissue parallel to the margin of the lid (Streatfeild, Snellen.)

All of the eight cases of *malignant tumors* of the lids were *Epitheliomata*. Four of them were operated upon and the defect covered by *blepharoplastic* operations. Extensive blepharoplasties were made for complete ectropium of both lower eyelids in a young man, whose face had been severely burned. The flaps were taken from the forehead, and both operations, performed by Dr. Knapp, were successful. I may mention that an attack of erysipelas of the face passed without injury to the transplanted flaps.

The following Table VII. shows the general statistics of all the eye-patients treated at the New York Ophthalmic and Aural Institute, since it was opened in May, 1869.

TABLE VII.

I. Affections of the Conjunctiva.

Conjunctivitis, catarrhal	3,378
" blennorrhoic and gonorrhoic	1,136
" " of the new-born	184
" phlyctænular	642
" trachomatous	1,275
" croupous	5
" diphtheritic	34
" traumatic	72
Burn with lime	23
Subconjunctival hemorrhage	117
Pterygium, internum and externum	45
" inferius	1

Pterygium superius	1
Symblepharon	27
Foreign body	88
Polypoid growth	32
Cyst	8
Pinguecula	4
Abscess	2
Lymphangiectasia	5
Argyrosis	2
Xerosis	2
Total,	7,083

II. Affections of the Cornea.

Circumscribed infiltration	48
Keratitis, phlyctænular	1,723
" " marginal	248
" pustular	174
" parenchymatous	319
" superficial ulcerous	335
" vascular	68
" traumatic	121
" ribbon-shaped	11
" purulent (cum hypopyo, abscess, serpiginous, etc.)	159
Kerato-iritis	119
Kerato-scleritis	1
Ulcer, simple	211
Ulcer, combined with prolapse of iris	29
" annular	1
Wound	148
" combined with wound of the iris, lens, sclera and prolapse	80
Cystoid scar	3
Herpes	5
Macula	429
Leucoma, simple	20
" adherent	226
" total	74

Staphyloma	130
Keratoconus	15
Burn (incrustation of lime and lead)	41
Epithelioma	3
Fibroma (?)	1
Xerosis	1
Arcus senilis	8
Foreign body	559
Total,	5,577

III. Affections of the Sclerotic.

Episcleritis	54
Wound	26
Staphyloma	30
Foreign body	1
Melanosis	1
Dermoid tumor	1
Melano-sarcoma	2
Fistule	2
Total,	117

IV. Affections of the Iris.

Iritis, simple (acute and chronic)	392
" specific	193
" " with gummy tumors	16
" serous	55
" purulent	20
" sympathetic	9
Irido-cyclitis	93
" specific	3
Irido-choroiditis	116
" specific	7
" purulent (metastatic)	20
" sympathetic	27
Hyperæmia	10
Posterior synechiæ	38
Occlusion of pupil	48

Mydriasis, traumatic	2
" medicamentous	52
" spontaneous	12
Myosis, spinal	9
Corectopy	2
Membrana pupillaris	4
Coloboma, congenital of the iris	11
" " " and choroid	6
" traumatic of the iris	9
Irido-dialysis	15
Irideremia	1
Iridodesis, traumatic	1
Foreign body	5
Atrophy, congenital	1
Cyst	6
Granuloma, traumatic	1
Melano-sarcoma	1
Hyphæma	7
	Total, 1,189

V. Affections of the Ciliary Body and Choroid.

Cyclitis	3
Melano-sarcoma of the ciliary body	2
Hyperæmia of choroid	28
Choroiditis, serous (detachment of retina)	110
" disseminate (atrophic)	147
" purulent (panophthalmitis)	35
" exudative	10
" tubercular	1
" ossifying	2
Perivasculitis	1
Hemorrhage	6
Chorio-retinitis, specific	45
Rupture, isolated	13
Melano-sarcoma	10
Albinism	4
	Total, 417

VI. Glaucoma.

Glaucoma, acute and subacute	25
" chronic	191
" hemorrhagic	2
" consecutive	6
" absolute	6
	Total, 230

VII. Affections of the Optic Nerve and Retina.

Hyperæmia of optic nerve	38
" of retina	35
Perineuritis (?)	7
Perivasculitis	2
Neuritis, optic	35
Neuro-retinitis, cause unknown	87
" Brightii	36
" sympathetic	3
" specific	6
Retinitis, hemorrhagic	37
" pigmentary	56
" specific (diffuse)	27
Retino-choroiditis, central	15
Atrophy of optic nerve, congenital	4
" " " idiopathic, and from drinking, etc.	371
" " " traumatic	2
" " " from neuritis	7
" " " cerebral	8
" " " spinal	5
Hyperæsthesia of retina	1
Anæsthesia "	2
Embolism of the central retinal artery	9
Opaque nervous fibres	7
Foreign body in retina	1
Glioma	12
Carcinoma of the outer sheath of the optic nerve	1
Tumor, probably myxoma	1
	Total, 815

VIII. Amblyopia.

Amblyopia, from excessive drinking, etc.	68
" congenital	1
" from anopsy	7
" from anæmia	4
" from central scotoma	3
" from injury	1
" from cerebral causes	2
" from unknown causes	26
Hemiopia	7
	Total, 119

IX. Affections of the Crystalline Lens.

Aphakia	19
Arcus senilis of the lens	7
Senile cataract, mature and immature	660
" " hypermature (Morgagnian, cystoid, disciform, etc.)	30
" " cholesteric	7
Cataract, chalky	2
" soft juvenile	18
" congenital	52
" zonular	43
" traumatic	154
" anterior polar (pyramidal)	35
" posterior polar	39
" secondary	74
" accreta	30
" glaucomatous	5
Dislocation, traumatic	72
" congenital	5
" spontaneous	4
Rupture of the posterior lens-capsule	1
	Total, 631

X. Affections of the Vitreous Body.

Synchisis, scintillans	1
Detachment of vitreous body	3

Myodesopsy	22
Opacities, simple	45
" membranous	8
Hemorrhage	15
Foreign body	5
	Total, 99

XI. Affections of the Globe.

Hæmophthalmus	24
Hydrophthalmus	15
Exophthalmus, cause unknown	14
Exophthalmus, from Grave's disease	5
Microphthalmus, congenital	13
Anophthalmus, from operation	6
Phthisis anterior	14
" bulbi	172
Foreign body	8
	Total, 271

XII. Refraction.

Myopia	309
" with sclero-choroiditis posterior	291
Hyperopia	648
Astigmatism, regular	63
" irregular	7
	Total, 1,318

XIII. Accommodation.

Presbyopia	184
Asthenopia	74
Paresis and paralysis of accommodation	69
Spasm of accommodation	3
	Total, 330

XIV. Affections of the Muscles.

Paralysis of oculo-motor nerve (third pair)	45
" " internal rectus	8
" " inferior "	9

Paralysis of superior rectus	2
" " " and inferior rectus	1
" " levator palpebræ and sup. rect.	7
" " levator palpebræ (ptosis)	55
" " the orbicularis	3
" " abducens (sixth pair)	58
" " trochlearis (fourth pair)	23
" " facialis (seventh pair)	5
Ophthalmoplegia	1
Insufficiency of internal recti	32
" " external "	1
" " superior oblique	1
Squint, convergent	838
" divergent	102
" upward	3
Nystagmus	24
Tendinitis	3
Blepharospasm	36
	Total, 1,271

XV. Fifth Pair.

Neuralgia, circumorbital	61
" supraorbital	9
Paralysis of	5
	Total, 75

XVI. Affections of the Orbit.

Caries	18
Periostitis	14
Periorbitis	29
Tumor (malignant)	25
Injury	5
Emphysema	3
	Total, 94

XVII. Affections of the Lachrymal Apparatus.

Dacryo-cystitis	151
Blennorhœa of sac	145
Stricture of duct and sac	144

Obliteration of sac	25
Abscess and fistule of sac	93
Tumor of sac	3
Leptothrix in canaliculus	1
	Total, 562

XVIII. *Affections of the Lids.*

Blepharitis ciliaris	999
Hordeolum	240
Chalazion (tarsal tumor)	235
Atheromatous cyst	32
Abscess	85
Ectropium	73
Entropium	184
Trichiasis and Distichiasis	46
Tumor (malignant)	57
Injury	53
Œdema	17
Ulcer, specific	9
Epicanthus	12
Phimosis	8
Phthiriasis	5
Burn	27
Eczema	52
Erysipelas	3
Pseudo-erysipelas	8
Sudamina	1
Variola	1
Ecchymosis	4
Emphysema	5
Lupus, specific	5
Anchylo-blepharon	1
Herpes	5
Erythema	1
Atrophy of lower lid (?)	1
Alopecia, specific	1
	Total, 2,170
	Sum total, 22,973

TABLE VIII.

Recapitulation and Relative Ratio of the Affections.

Conjunctiva,	7,083	31
Cornea,	5,577	25
Sclerotic,	117	½
Iris,	1,189	5
Ciliary body and choroid,	417	2
Glaucoma,	230	1
Optic nerve and retina,	815	4
Amblyopia,	119	½
Lens,	1,231	5
Vitreous body,	99	½
Globe,	271	1
Refraction,	1,318	5½
Accommodation,	330	1½
Muscles,	1,276	5
Fifth pair,	75	⅓
Orbit,	94	½
Lachrymal apparatus,	562	2½
Lids,	2,170	9⅓
Total,	22,973	100

The following table IX. gives account of the operations performed at the New York Ophthalmic and Aural Institute since 1869.

TABLE IX.

I. Lens.	Success. Good.	Moderate.	Failure.	Total.
Graefe's extraction of mature and hypermature senile cataract,	192	13	14	219
Graefe's extraction of traumatic and complicated cataract,	29	6	13	48
Weber's extraction,	13	2	1	16
Division of soft cataract,	67	2		69
" " secondary cataract,	33	2		35
Total,	334	25	28	387

II. Iris.	Success.			
	Good.	*Moderate.*	*Failure.*	*Total.*
Iridectomy for glaucoma, ...	140	10	4	154
" " adherent leucoma, ...	67	2		69
" " simple "	15			15
" " occlusion of pupil, ...	43	2	2	47
" " iritis, ...	14			14
" " irido-cyclitis, ...	16	2	2	20
" " " sympathetic, . .	2	1	2	5
" " irido-choroiditis, chronic, . .	5	1		6
" " " purulent, . .			1	1
" " " sympathectic, .			1	1
" " foreign body in iris, ...	3			3
" " cyst of iris, ...	3	2		5
" " corneal staphyloma, ...	8			8
" " scleral "	1			1
" " anterior polar cataract, . .	4			4
" " traumatic cataract, ...	4			4
" " zonular "	15		2	17
" " cholesteric "	3			3
" preparatory to extraction, ...	4			4
" for kerato-iritis, ...		1		1
" " hæmophthalmus, ...		1		1
" " sarcoma of iris, ...	1			1
Iridotomy, ...	3		1	4
Iridencleisis (for irido-dialysis), ...	2			2
Removal of entire iris, ...	1			1
Abscission of prolapse of iris, ...	78			78
Removal of traumatic granuloma of iris, . .	2			2
Total, ...	434	22	15	471

III. Muscles.	Success. Good.	Moderate.	Failure.	Total.
Tenotomy for convergent squint,	843	4	2	849
" " divergent squint,	66			66
" " upward squint,	7			7
" " downward squint,	2			2
" " insufficiency,	15	1		16
Advancement of internal rectus,	25	2		27
" " external "	6			6
Total,	964	7	2	973

IV. Lids.	Success. Good.	Moderate.	Failure.	Total.
Operation for entropium,	187	2	1	190
" " ectropium,	13	1	1	15
" " ptosis,	44	1		45
" " symblepharon,	8	1	1	10
" " canthoplasty,	25	1		26
" " epicanthus,	4	5		9
Blepharoplasty,	25			25
Tarsoraphy,	7			7
Temporary closure of palpebral fissure,	2			2
Modelling of flaps after blepharoplasty,	3			3
Suture for wound,	10			10
Removal of tarsal tumors,	219			219
" " epithelioma,	8			8
" " angioma of lid and forehead,	17			17
" " xanthelasma,	5			5
" " scars,	2			2
" " foreign body imbedded,	2			2
Total,	581	11	3	595

V. Cornea.	Success.			
	Good.	*Moderate.*	*Failure.*	*Total.*
Paracentesis,	14	3		17
Keratotomy (Saemisch's),	21	3	2	26
Operation for staphyloma (Knapp's),	47			47
" " " (Küchler's),	6			6
" " keratoconus,	1			1
Tattooing of leucoma,	9	3		12
Removal of deposits of lead,	8			8
" " ribbon-shaped opacity,	1			1
" " tumor of corneo-scleral junction,	2			2
Total,	109	9	2	120

VI. Sclerotic.	Success.			
	Good.	*Moderate.*	*Failure.*	*Total.*
Suture of wound,	2			2
Removal of foreign body imbedded in,	2			2
Total,	4			4

VII. Vitreous Body.	Success.			
	Good.	*Moderate.*	*Failure.*	*Total.*
Paracentesis,	2			2
Removal of foreign body,	1			1
Total,	3			3

VIII. Retina.	Success.			
	Good.	*Moderate.*	*Failure.*	*Total.*
Paracentesis, ...	1			1

IX. Globe.	Success.			
	Good.	*Moderate.*	*Failure.*	*Total.*
Enucleation for manifest sympathetic affection, .	50			50
" prophylactic, ...	62			62
" for absolute glaucoma, ...	6			6
" " intraocular tumor, ...	21			21
" " corneo-scleral tumor, . . .	2			2
Total, ...	141			141

X. Orbit.	Success.			
	Good.	*Moderate.*	*Failure.*	*Total.*
Removal of tumor with globe, ...	4			4
" " " " preservation of the eyeball,	6		1	7
" " foreign body, ...	2			2
" " necrosed bone, ...	4			4
" " supraorbital tumor, ...	6			6
Total, ...	22		1	23

XI. CONJUNCTIVA.	SUCCESS.			
	Good.	*Moderate.*	*Failure.*	*Total.*
Removal of cyst, ...	11			11
" " polypoid growth, ...	32			32
" " foreign body deeply imbedded in, .	2			2
" " pterygium, ...	18			18
Total, ...	63			63

XII. LACHRYMAL APPARATUS.	SUCCESS.			
	Good.	*Moderate.*	*Failure.*	*Total.*
Obliteration of sac, ...	9			9
Removal of tumor, ...	4			4
Plastic operation for fistule, ...		1		1
Stilling's operation, ...	4			4
Total, ...	17	1		18
Sum total of eye-operations, ...	2678	70	51	2799

OSSIFICATION OF THE CRYSTALLINE LENS.

By ALFRED VOORHIES, M.D., Memphis, Tenn.

The formation of true bone in the crystalline lens, up to the present time, stands in the catalogue of questionable existence, but from the specimen now before me, the fact of such an existence is demonstrated beyond a doubt.

This history of the case is briefly this:—

In December, 1876, I was consulted by a girl 18 years of age, in regard to her eyes. She had suffered with some disease of the left eye since early childhood, and had lost the sight of it before she could recollect.

It was subject to painful inflammations, coming on by spells at irregular intervals, lasting from two weeks to as many months.

Of late these attacks were more protracted and attended by an increase of pain.

During the last spell the right eye participated to some extent, and from the intolerance of light, lachrymation, and dimness of sight she became greatly alarmed.

On examination of the eyes I found the sight $S=\frac{1}{2}$, with slight opacities dotted over the lower half of Descemet's membrane, reminding one of large flakes of snow recently fallen on the bare ground.

The iris was dusky and irregular in its pupillary opening. In short, an unmistakable case of serous iritis from sympathetic irritation.

The left eye was shrunken, cornea perfectly clear, anterior chamber very shallow, with iris firmly adhered to capsule of lens, and with pupil not larger than the head of a pin.

No perception of light for the past ten years.

The ciliary body was evidently in a state of chronic inflammation, and inducing the sympathetic trouble to the other eye.

I advised extirpation of the left eye, which was submitted to without delay.

The wound headed readily, but for some weeks it was feared she would lose the other eye.

Its recovery was finally accomplished through the influence of the persistent use of the iodide, atropine, and darkened room.

Immediately after the enucleation, I made an equatorial section of the globe. A small quantity of yellow fluid was in the vitreous chamber, the retina degenerated and almost wholly detached from the choroid, while the choroid itself was thickened and granular in appearance, especially on its inner surface. The sclerotic was much thicker than natural.

The crystalline lens was in its normal position, of usual size, perfectly opaque and as hard as a stone, with the iris firmly attached to its anterior surface. The ciliary processes represent a perfect cast around the periphery.

Microscopic examination shows the entire lens to be in a state of ossification, characterized by Haversian canals and a concentric arrangement of the bone corpuscles around them.

The other tissues, especially the uveal tract, were submitted to careful microscopic examination, but no trace of real bone could be found in any of them.

For the mounted specimen accompanying these notes, I am indebted to Dr. Cutler of this city, who is favorably known as a microscopist.

ON THE DEVELOPMENT OF THE EYE IN MAMMALS.

BY ARTHUR WÜRZBURG, OF BERLIN.

(From investigations made in the Histological Laboratory of *Dr. Ludwig Löwe* in Berlin.)

(Hereto plate IX. of Vol. V. Ger. Ed.)

TRANSVERSE sections through the eye of rabbit embryos presented to me some peculiar conditions, especially concerning the derivatives of the epithelial germinal membrane, which seemed worthy of further investigations.

For the examination two stages of fœtal development were used, which corresponded to the size of embryos of about 2—3 and 6—8 centimetres in bodily length. They were prepared after the method used by *Dr. Löwe* in such a manner, that the embryos were first hardened in bichromate of potash, later in absolute alcohol, then colored *in toto* in carmine, imbedded in glue and wax, and finally cut by means of a *Gudden's* microtome. Only such horizontal sections were used, which went entirely or nearly through both eyes near the optic papilla, through both nervi optici and through the chiasma nervorum opticorum.

I shall begin with the results of my investigations on the development of the iris and of the corpus ciliare. But I shall first have briefly to recapitulate the incident literature.

The authors before *Kölliker* were ignorant of the fact that the pigment of the choroid (of the corpus ciliare and iris) is only the reflected lamella of the retina. For this reason they considered the tapetum as belonging to the tissue of the cranial plates, and did not as yet divide the development of the iris and of the corpus ciliare into the two classes in which the development of these parts must naturally be analyzed; namely, in the genesis of the pigment and in that of the substratum of

connective tissue. All statements of authors before *Kölliker* concerning the iris and the corpus ciliare possess, therefore, only a historical value, and only for the sake of completeness I shall cursorily mention them. *V. Baer** thinks that the iris takes its origin in folds formed by the corpus ciliare, but he cannot yet determine whether the ciliary body and the corona ciliaris are of later formation, or whether they had previously developed, but were hidden, up to the time of their becoming visible, under the retina and the vitreous.

According to *Malpighi, Haller, Autenrieth, Sömmering, Meckel, Huschke, Joh. Müller* and others,† the iris first appears in the form of a split and unpigmented ring, whereas *F. Arnold*† denies the splitting. *Von Ammon*‡ takes a mediating position, in so far as he also denies a splitting, but states that the iris becomes narrower on its inner-lower side—that is, near the so-called choroidal fissure—than on the other sides. Apart from that, he asserts that the iris is not directly connected with the anterior end of the choroid, but by the interposition of a finely reticulated tissue. *Remak*§ makes no detailed statements on the formation of the iris and the corona ciliaris; he only asserts that, at the end of the fourth day, black pigment appears on the external surface of the ocular vesicle as the first indication of the choroid, iris, and corpus ciliare.

Whilst the above-mentioned authors give but scant information on the development of the iris, they treat at length another point; that is, the further destiny of the outer layer of the secondary ocular vesicle. Some (*Remak*‖) state the entire choroid; others (*Huschke, Schöler, A. Müller*‖) on the contrary that only the columnar layer of the retina is derived from it. This controversy has been settled by *Kölliker*, who discovered the fact that it is not the choroid, but a part of the retina, *i. e.*, the tape-

* Cited after Julius Arnold. Contribution to the History of the Development of the eye. Heidelberg, 1874, page 58.

† The same.

‡ Graefe's Archiv für Ophthalmologie, 1858.

§ Cited after Julius Arnold.

‖ Cited after *Kölliker*, History of Development, 1861, page 287.

tum, that is derived from the external layer of the secondary ocular vesicle. The corpus ciliare and the iris, as they consist of pigment as well as of connective tissue, must therefore be derived from two sources; namely, on the one side from the secondary ocular vesicle, and on the other from the tissue of the cranial plates. *Kessler* is the first who gives more extensive information in regard to the details of the formation of the iris and corpus ciliare, which, in its outlines, had been described by *Kölliker.* He resumes his observations on the eye of birds as follows:*

From the seventh day, there appears in the anterior section of the secondary ocular vesicle an attenuation of that part of the inner lamella which lies in contact with the free border of the lens. This process results in a division of the lamella into two parts. The posterior part of the secondary ocular vesicle forms all the layers of the retina, by a process of differentiation. On the 10th day, a new division takes place by the formation of folds in the anterior attenuated zone. The part of both lamellæ of the secondary ocular vesicle, situated in front of the fold, is changed into the pigment of the iris; while the portion behind the anterior edge of the fold supplies the pigment through its external lamella, and the unpigmented epithelium of the ciliary body through its inner lamella. The iris portion of the secondary ocular vesicle extends from the peripheral edge of the iris to the ora serrata, where it passes over into the retina without showing a well-marked boundary line. The thinning of the anterior portion of the secondary ocular vesicle is unaccompanied by any recession of the anterior fold; this latter, on the contrary, grows and projects, and thus aids in forming the vitreous chamber.

According to *Kessler*, two layers of pigment cover the posterior wall of the iris, whilst the corpus ciliare is posteriorly lined by one layer of pigment, and an epithelial covering

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* Cited after *F. Lieberkühn:* "On the Eye of the Embryo of Vertebrata. Records of the Society for the Advancement of Natural Sciences at Marburg, Vol. 10, part V. Cassel," 1872, p. 327. I was not able to procure *Kessler's* treatise from booksellers.

representing the continuation of the retina. *Lieberkühn** agrees with *Kessler's* statements regarding the eye of the bird, as far as they are founded on fact, but disputes certain theoretic deductions at which *Kessler* has arrived as regards the development of the iris.

According to *Sernoff*† the iris grows out of the peripheral parts of the anterior half of the temporary capsule of the lens, with which it is connected in the beginning, but separated only later on. The edge of the ocular vesicle moves forward toward the posterior surface of the iris; the external layer giving rise to the true layer of pigment of the iris, the internal to the so-called membrana pigmenti.

Julius Arnold confirms the views of *Kessler* (and of *Lieberkühn*) regarding the first development of the iris and corpus ciliare. "Whether and in what manner the anterior lamella participates in the composition of the full-grown iris is not easily to be decided. It is a fact, that the band corresponding to the ciliary portion of the retina exists as a narrow edge on the anterior surface of the ciliary processes, and never terminates abruptly, but becoming considerably narrower, can almost always be traced over the posterior surface of the iris." *Arnold* never succeeded in proving its existence near the edge of the pupil. In regard to the zonula, *Arnold* says that it originally is a formation of the vitreous; in a more advanced stage of development it becomes connected near the ora serrata with the retina.

Arnold does not decide the question whether the iris and corpus ciliare grow at the same time, or whether the iris is formed later than the corpus ciliare.

According to *Schenk*,‡ the pigment of the iris originates from the secondary ocular vesicle. He notices that, on the most anterior part of the ocular vesicle of the larger embryos, the formation of pigment partly passes over from the external lamella to the internal. This portion then becomes thinner, covers the

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* The same, page 348.

† *Sernoff:* On the Development of the Capsule of the Lens. Preliminary communications. Centralblatt für die medizinischen Wissenschaften, 1872.

‡ *Schenk:* First Principles of Embryology. Vienna, 1874, p. 44.

embryonal corpus ciliare, and is continued up to the lens, into the iris. Therefore it becomes clear that all pigment layers of the eye originate from the external germinal membrane. I fully concur with these briefly intimated but correct observations of *Schenk*.

After this *résumé* of the literature, we shall pass over to the description of the sections found on plate IX. Fig. 1 represents a horizontal section, carried, somewhat over the level of the optic-nerve entrance, through the eye of an embryo of a rabbit of about 2–3 centimetres in length; *l c* is the lens, *t c* the cornea, *r* the retina, *t* the tapetum, *c w* the vitreous, *g g* its vessels. The germs of the iris and the corpus ciliare lie before the equator of the lens at the point where the retina *r* goes over into the tapetum *t*. Here two peculiar folds α and β become visible, of which the anterior α indicates the position of the iris, and the posterior β that of the corpus ciliare. These folds originate in the following manner.

In sections like the present, which are made horizontally through the eye, somewhat above the entrance of the optic nerve, there are met with three folds α, β, γ, placed one behind the other, and an odd median fold δ, situated above the entrance of the optic nerve. The tapetum repeats all these folds, but as it lies on the external surface of the retina, it cannot naturally describe such large circles as the retina itself. For the same reason it is also evident that, if a knife be passed straight over the lateral edge of a retinal fold, it would encounter only windings of the retina, and would apparently miss those of the tapetum. Such is the case in our figure with fold γ on the right side, while in fold γ on the left, the bend of the tapetum is but faintly indicated. If, on the contrary, the section be made exactly in the axis of a fold, it becomes evident that the tapetum follows the course of the fold in its full length. In the case of the single median fold δ, the tapetum is even doubly bent in the shape of an *n*; this shows that the odd median fold originally was formed out of two symmetrical lateral folds, blending in the median line. Of all these folds, fold δ is so located that it lies exactly over and in the direct prolongation

of the optic nerve, consequently covering the papilla nervi optici from above. Fold γ takes its direction inward and backward, thus causing a small prominence of the vitreous ε behind it. Fold β protrudes directly from without inward, and is the first indication of the corpus ciliare; finally, fold α shows the point of transition of the retina into the tapetum, or the origin of the iris. The iris and the corpus ciliare owe their origin to a process which consists of the repeated formation of folds in the brain-substance of the retina. These folds are to a certain extent analogous with the convolutions of the brain, and are indeed likened to them by certain authors.

Of these windings of the retina, the first develops to form the iris, for which reason I term it either the iris-fold, or the transition fold of the secondary ocular vesicle; the second shapes itself into the corpus ciliare, it may therefore be called the ciliary fold; the third forms externally the macula lutea (internally this fold seems to have no function in mammals, and later becomes atrophied), and I propose to call it the macular fold; finally the fourth, δ, participates in the formation of the papilla nervi optici, on which account it may be termed the papillary fold. The retina r shows already at this time the greatest development in its middle parts behind the posterior circumference of the lens and on both sides of fold δ, and consists here (excluding the tapetum) of two distinctly separated layers (see below). Anteriorly close to the point of transition of the retina into the tapetum, we find in mammals a single layer of cylindrical cells X (this is best seen in fig. 2 at X, which is a magnified representation of the left anterior side of fig. 1). Immediately at the termination of the retina, consisting at this part of but one layer, as above mentioned, the pigmented iris is seen in the form of a narrow, striated, slightly bent prolongation, directed inward toward the lens. This is the stage of development of the first iris represented in figs. 1 and 2. In a prior stage the iris does not as yet exist, and the retina simply passes into the tapetum at an acute angle. A separate, independent iris is formed when the apex of the secondary ocular vesicle bends itself into the shape of a hook. The retina

accordingly, in a slight hook-like bend, passes into the pigmentary layer which at this point forms the folds β, γ, and δ, and closes after having met the pigmentary layer of the other side. Before considering this condition any further, we shall examine the corpus ciliare.

As in the fully developed eye the single processus ciliares are separated from each other by a depression, so also in the embryonal eye eminences and depressions of the corpus ciliare alternate. In an embryo of this stage I have counted about seventy ciliary processes which were separated by as many depressions.*

The section through the embryonal eye therefore appears just as different as through the full-grown; the picture varying as the cut either passes through a ciliary process or through a depression between two processes. In fig. 1, both appearences are represented, so that, while on the left side the section passes through a ciliary process, it strikes a depression on the right side. The iris-fold α is thus seen to pass directly from before backward into the macular fold γ without any trace of the ciliary fold β.

The transition of the pigmentless parts of the retina into those containing pigment is effected in the following manner. The first trace of pigment is found in single grains, which appear scattered in the substance between the cylindrical cells of the retina, as especially in fig. 2 at *X*. *Arnold*† has lately proved that between the epithelial cells of the mucous membrane of the palate there is a substance which assumes a blue color by an injection of indigo-carmine, and to which he gives the name of cement ridges. These so-called cement ridges are also found between the epithelial cells of the retina in the region of the iris and corpus ciliare. If this experience of *Arnold* as

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* This number is not exact, as I could place only a segment of the very minute eye in such a position as was necessary for the purpose of counting the processes. This had to be done under the microscope, in such a manner that each time that number of ciliary processes were counted which happened to be contained in the segment under observation. How large a part of the whole globe was represented by the segment in question could only approximately be determined.

† Centralblatt, 1875, No. 51.

regards the process of pigmentation is applied to the retina, it becomes apparent that the first deposit of pigment does not take place in the cells proper, but in the substance lying between the cylindrical cells of the retina. Gradually the deposit of pigment between the cells becomes more dense, so that the whole space between them is occupied by closely packed pigment molecules. Finally the pigment infiltrates the cells themselves, and generally in such a way that their ends turned toward the primitive ocular vesicle are more densely pigmented than those pointing to the opposite direction, as can be seen on fig. 2. Throughout the extent of the tapetum, the nucleus of the pigment cells remains well preserved, and becomes colored by carmine. Moreover, the limit of each single pigment cell of the tapetum is distinctly recognized through the entire thickness of the posterior membrane of the secondary ocular vesicle. Finally the cells of the tapetum at the place of the origin of iris and corpus ciliare are higher than those placed farther back, so that from the very first there is more pigment in the anterior part of the secondary ocular vesicle than in the posterior. If very thin sections are not used, the thick deposit of black pigment at the points of formation of the iris and the corpus ciliare can easily lead to the false supposition that the pigment cells in these places are arranged in several layers. But in very thin sections it is seen that, as in the entire circumference of the tapetum, so also in folds α and β there exists only a single layer of pigment cells, which are indeed to be distinguished in these two folds by their greater height from those lying posteriorly in folds γ and δ.

Numerically expressed the height of a single pigment cell in fold α and β measures 27 and 29 μ, whereas in folds γ and δ only 16 μ.

From the above it follows that the pigment first becomes deposited in the cement substance between the cells of the tapetum, and penetrates later into the cells themselves. Here we always find a denser infiltration in the extremity of the cell turned toward the cavity of the primary ocular vesicle.

The view just presented is upheld, at least in its principal

points, by the older authors. One of the most recent authors, *Jul. Arnold*,* on the contrary thinks himself justified, on the basis of his investigations, to express different views concerning the manner of the deposit of pigment. He is inclined to believe that the posterior membrane of the secondary ocular vesicle becomes atrophied, and that pigment cells are formed in its place in a manner that the more cells are atrophied, the more pigment cells appear. The reasons which *Arnold* gives in support of his views are the following. *Arnold* discovered the important fact that pigmentation begins in the centre of the posterior membrane of the secondary ocular vesicle, *i. e.*, in the papillary fold δ, and thence spreads forward on both sides. Upon the strength of this fact, *Arnold* asserts that, if the cells of the posterior membrane of the secondary ocular vesicle really become transformed by the absorption of pigment, into cells of the tapetum, the pigmentation ought to be least marked at the point of transition into the anterior membrane, while in reality the contary takes place. *Arnold* seems therefore to uphold the theory that the degree of pigmentation depends upon the duration of that process, *i. e.*, that a cell in which pigmentation has been going or for some time, should be much darker, and contain considerably more pigment grains than one which has but lately become infiltrated with pigment. This supposition is hardly conclusive, for of two unequally pigmented cells, the one which has just completed the process of absorbing pigment may have become more pigmented than the one in which the pigment had been deposited and stored before. But in *Arnold's* hypothesis an objection is contained which tends to subvert this view of the possible origin of pigment. In the case of an atrophy, those parts first atrophied should obviously be the most pigmented, and in accordance with *Arnold's* hypothesis, the greatest amount of pigment should be found at the optic nerve. But such is not the case. Consequently *Arnold's* supposition cannot be correct. In my opinion, there is a different reason why the pigmentation is most marked at

* The same.

the point of transition of the retina into the tapetum. The greater part of the posterior membrane is still present at that point (of which one can easily convince himself by observing the unpigmented eyes of albinotic rabbits), and the epithelial cells of the posterior lamella are largest in the iris-fold α and ciliary fold β, becoming smaller as they approach the papilla. The cells of the tapetum in albinotic rabbits measure in the iris-fold 17 μ, and in the macular fold only 6 μ. The larger a cell, the more pigment it is able to absorb under otherwise similar conditions. With this view agree also the measurements of the completed tapetum. Whilst it is thickest at the point of origin of the iris and corpus ciliare, it decreases in thickness as it approaches the papilla.*

According to my specimens it appears to me highly probable that the observation of *Arnold* is correct, according to which pigmentation begins at the papilla nervi optici, thence spreading forward. Although my investigations do not include the very first stages of development of the eye, as very young mammalian embryos were not at my command, they teach at all events how later on pigmentation advances, thus allowing a conclusion as to the first deposit of pigment, and it is seen that in the external membrane pigmentation advances in the direction of the papilla toward the iris, whilst in the internal membrane in the contrary direction, of the iris toward the posterior pole of the lens. The process of pigmentation takes place most probably in such a manner that the first pigment is deposited in the form of fine molecules in the cement between the still unpigmented cells of the tapetum, close to the papilla nervi optici, at the point δ represented in figure *I.*, thence spreading toward the iris until it finally doubles over the interior mem-

* On fig. *I.* it is to be seen that the pigment cells of the tapetum have greater dimensions at the iris-hook than in any other part of the ocular vesicle. But we cannot recognize that the pigment cells become smaller close behind the iris-hook and continue to diminish as they approach the papilla. The cause of this fault in the figure is, that the drawing was made after a photograph. Whilst in α and β the the pigment cells are seen in profile, they present a surface view on both sides of δ, owing to a folding of the tapetum.

brane of the secondary ocular vesicle (compare fig. *II.*). (*Dr. Löwe* has found that the pigmentation of the internal surface of the retina extends even during growth to the commencement of the ciliary folds. Thus in the eye in formation, two layers of pigment are to be found in the posterior surface of the iris.)

It follows from the history of the development of the first pigment in the eye, presented above, that some of the published drawings of the tapetum cannot be correct. In this respect I only wish to mention the two latest works about the eye, that of *Arnold* (l. c.) and that of *Lieberkühn* (l. c.). In *Arnold's* illustrations it is especially the representations on plate II., figs. 5, 6, 7. Apart from the fact that the vestiges of the primary ocular cavity have been omitted on all figures upon which *Arnold* represents pigment, the transition of the unpigmented into the pigmented cells is nowhere indicated on figures 5, 6, and 7. Moreover, I remarked in particular that *Arnold* represents at the same time on figure 5 both pigment and the posterior wall of the ocular vesicle, whilst on the other side he allows the latter to pass gradually, without leaving any trace, into the layer of connective tissue of the cranial plates. In like manner, one misses in figure 6 the posterior limit of the posterior lamella of the ocular vesicle. For the same reason I must object to fig. 32 in *Lieberkühn* (l. c.). Moreover in figure 14, *Lieberkühn* places the pigment molecules incorrectly, *i. e*, in the distal instead of the proximal ends of the cells of the tapetum.

According to *Kessler*, the iris in the full-grown bird is surrounded on its posterior side by a double layer of pigment. He therefore concludes by analogy that in the fully developed eye of mammals the retina or a corresponding layer of cylindrical or pigment cells is continued to the papillary edge, and that thus in man likewise the inner surface of the iris is covered by two layers of retinal pigment. *Lieberkühn* could not corroborate this hypothetic assertion of *Kessler*. He could show only a single layer of pigment cells on the lower surface of the iris, at least in the older embryos and full-termed mammals, whilst in very young mammalian embryos two layers of pigment were indeed found. From this *Lieberkühn* draws the conclusion that *Kessler's* representation, according to which both retinal layers extend uninterruptedly to the pupillary edge, cannot be accept-

ed as regards the full-termed mammal and the more advanced mammalian embryo. He believes that the point of transition of the anterior into the posterior layer of the secondary ocular vesicle is to be looked for further behind (in the region of origin of the iris), and that from this point a single layer of pigment, caused perhaps by the fission of the two layers of the secondary ocular vesicle, extends forward.

Upon the strength of *Dr. Löwe's* specimens, I nevertheless uphold the correctness of *Kessler's* assertion, in contradiction to that of *Lieberkühn*, concerning the full-grown eye of mammals.

According to these specimens, the posterior surface of the fully developed iris is distinguished from the posterior surface of the embryonal iris by the fact that in the embryo only one layer of pigment cells is found behind the iris, the other internal layer being unpigmented; whilst, according to the specimens of *Dr. Löwe*, two layers of pigment cells are found on its posterior surface. *Faber* * also mentions that several layers of pigment cells are present on the inner surface of the iris of fully developed mammals' eyes. It follows from the results just given concerning the fully developed eye, that with the advancing growth pigmentation also progresses.

I shall once more sum up the facts of the genesis of pigment. Pigmentation begins in the tapetum above the entrance of the optic nerve, from there it extends forward, then passes over the edge of the iris, and finally spreads upon the inner lamella of the secondary ocular vesicle. Here it occupies a variable extent of the retina, and in mammals terminates at the height of the origin of the iris.

The following condition on fig. 3 is taken from an embryo of a rabbit not quite 7 centimetres in length, and is represented considerably less enlarged than fig. 1. (Fig. 1 is magnified about 40 diameters, whilst fig. 3 is only magnified 10 times.)

Fig. 3 again represents a horizontal section through the eye at the height of the point of entrance of the optic nerve. *Lc*

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* *Faber:* The Structure of the Iris of Man and the Vertebrates. Leipzig, 1876, page 57 and the following.

is the lens, *tc* the cornea, *r* the retina, *p* the eyelid, through the substance of which the section is made obliquely, so that its upper border, covered with epithelium, is seen in the centre; *x* is canthus externus, and *y* canthus internus; *t* is the tapetum, *cw* the vitreous, *ch+s* the indication of the choroid and sclerotic.

If we consider the changes which show the differences existing between the former and the present conditions, we find that, above all, the dimensions have increased considerably. A tabular comparison of the separate parts of the eye is annexed to this small treatise. Moreover, we shall notice that even within the separate parts important changes have occurred, of which those concerning the iris and corpus ciliare are of special interest to us. The iris-fold has become S-shaped and shows indeed on both sides the form of a capital Roman S, placed horizontally and vertically upon the axis of the eye. The inner part of the S turns its concavity forward, and the lateral part turns it backward. Pigmentation (compared with the stage of the eye before mentioned) has extended somewhat more backward and inward, so that a larger part of the retina (posterior layer of the iris) is already pigmented.

Fold β (corpus ciliare) is now considerably deeper, and on the right side curved inward and backward, *i. e.*, in the direction of the papilla nervi optici, whilst on the left it is still directed inward toward the lens. With this process a change of form of the entire globe is connected, which even now does not appear entirely round in transverse sections. This metamorphosis is best seen on the two lithographs (figs. 1 and 2) annexed to this work. The asymmetry of both lateral halves of the globe is particularly striking. Whilst the external section of the globe is limited almost by a straight line in the direction of the orbit, (on the right on fig. 3), the internal is bent in a half-circle in the direction of the part looking toward the nose (on the left on fig. 3). Whilst on the left the macular fold γ is well preserved and projects into the globe, it has almost disappeared on the right side, and in its place is even found a depression in the pigmentary layer. This circumstance led me to infer that this

is the first appearance of the macula lutea. *If this be really the case, it follows that the yellow spot in mammals (and probably in all vertebrates) is at first formed symmetrically on both sides of the papilla, and consists originally of a formation perfectly similar to that of the corpus ciliare; namely, a retinal fold projecting into the interior of the eye. The inner fold persists longer than the outer, which in consequence of the irregular growth of the eye becomes flattened, and finally depressed, thus forming the fovea centralis maculæ.*

Upon the irregular growth of the eye also depends the dislocation which takes place in the lens *lc* and the optic nerve *no*. The lens rotates in such a manner that, given a point in its centre as a fixed turning point, the anterior end of the axis of the lens turns inward, and its posterior end outward.* With this change of the direction of the axis of the lens is also connected, at the same time, a change of form of the whole lens. Whilst, in former stages, the space inclosed by the capsule of the lens had on each section an oval, almost circular contour, and the transverse diameter exceeded only by a little the longitudinal (fig. 1), the lens has, as shown in fig. 3, almost the form of a trapezium. In this stage, the transverse diameter considerably surpasses the longitudinal. The asymmetry between the inner and outer halves of the lens is here very striking. Whilst the inner line of contour of the lens (left on the figure) measures 695 μ, the outer measures only 639 μ. This absence of symmetry is noticeable in the relations of the internal and external (left and right) halves of the cornea. On the left side it measures 111 μ in thickness, on the right only 83 μ. The vitreous *cw* likewise shows considerable variations on the two sides, filling broadly all the vertical depressions on the left, and forming but narrow bridges of substance between the closely packed retinal folds on the right side, where the lens lies in greater proximity to the retina. (It is, however, possible that the asymmetry of the internal and external sections of the globe is not so great in differently preserved eyes. My method of preparation does not always preclude the possibility of dislocations.)

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* Compare *Samelsohn*. Centralblatt für die med. Wissenschaften, 1875, p. 343.

The nervus opticus on fig. 3 does not enter exactly in the axis of the eye, as the well-known inward displacement of the papilla of the full-grown eye has already commenced. The curve of the entire optic nerve is remarkable, its convexity not being turned outward (toward the brain) as in the fully developed human eye, but inward (toward the nose). The rotation of the embryonal globe has often been described (vide *Manz* in *Graefe* and *Saemisch*, Vol. II. 1). Of the views here expressed, the most probable seems to be that which considers an irregular growth of the single parts as the cause of rotation. In the rabbit's eye this can be proved by measurement. As can be seen in comparing figures 1 and 3, the inner line of contour of the eye has grown 778 μ, and the external 1261 μ during the time elapsed between the two stages. In the same manner the lens has grown 76 μ in its inner, and 20 μ in its outer sections, or, as in the lens the lateral growth is preponderating, its greatest anterior transverse diameter has grown 111 μ and its greatest posterior transverse diameter 445 μ.

An additional question would be, what are the causes of the difference in the energy of growth? Concerning these I have not been able to obtain any information.

I shall now turn to a description of the histological development of the retina in mammals. The embryonal retina in mammals has scarcely yet been an object of investigation. There exists, however, a systematic work by *Babuchin* on the development of the retina in amphibians and birds.* This treatise is especially remarkable for the beauty of its illustrations and the completeness of its details. In the first stage, according to *Babuchin*, the retina in birds consists of nothing but a single layer of radiating cells whose nuclei lie in different elevations, so that they may easily be mistaken for several layers. *Müller's* fibres are said to originate from these cells by an increase in length in the membrana limitans interna by the blending of the inner extremities of the fibres. The ganglion cells are said to form in such a way that the internal sections of the radiating original

* *Babuchin:* Comparative Histological Studies. Würzburg Journal of Natural Sciences, V. 1864.

elements of the retina become separated by division from the exterior sections. Thirdly, the layer of nerve-fibres is supposed to be formed by the growth of the prolongations of the ganglion cells. Consequently we may now differentiate: 1) *Müller's* fibres and 2) membrana limitans interna, 3) ganglion cells, 4) layer of nervous fibres. The remainder of the original deposit furnishes, according to *Babuchin*, all the other layers (granular and molecular) by the proliferation of the cells. The differentiation of the various laminæ is thought to begin at the posterior part of the ocular vesicle and to continue forward. *Babuchin* considers the membrana limitans externa essentially as the optical expression between the limits of the intercellular substance of the retina and the termination of *Müller's* fibres.

Upon the two illustrated specimens prepared by me, the development of the retina appears quite different. It must therefore be taken for granted, provided the observations of *Babuchin* are correct, that the development of the retina in mammals is totally different from that in birds and amphibians. The retina of an eye as represented on fig. 1 measures in its thickest part, at the entrance of the optic nerve, 195 μ (without the nervus opticus), and decreases gradually in thickness from the centre of the papilla in the direction of the ora serrata, so that the ora itself now measures only 56 μ. Near the papilla of the optic nerve (Fig. 5), it consists (counting from before backward) of the following layers: tapetum *t*, layer of darker elements *u*, layer of lighter elements *m*, and a fibrous layer *f*.

It has been mentioned before that the tapetum is thinnest at the papilla nervi optici (measuring 17 μ), and consists of a single layer of nucleated cells. The cell protoplasm is filled with pigment granules, which is more thickly deposited at that end of the cells which turn toward the cavity of the primary ocular vesicle, *pah*. The cement between the epithelial cells also contains a large quantity of pigment. The pigment has not the rod-like form which it possesses in the full-grown eye, but consist of round granules measuring only the fraction of a μ. If the single granules are accurately focussed, they appear bright in the centre and are surrounded by a very fine

dark line; if the screw is turned somewhat higher, there appears in the middle of the bright centre a small dark spot. Accordingly such a pigmentary granule consists of a dark centre, which is bounded first by a bright ring, while the entire corpuscle is bounded externally by a dark ring. An independent membrana limitans externa does not yet exist, but the original retinal elements are separated at most places by a thin zone *n* from the cavity of the primary ocular vesicle. This zone is interrupted by the small semi-spheroidal bright elevations *s*, which protrude into the remainder of the cavity of the primary ocular vesicle.

The layer of small dark corpuscles *u* consists of a homogeneous matrix in which are imbedded closely packed roundish nuclei. These nuclei have a diameter of 9 μ. They do not lie quite close against each other, there being a bright zone between every two nuclei. They are distinguished from the nuclei of the layer of bright granules by their power of absorbing carmine, so that even in the case of teased specimens, it is as a rule not doubtful whether we have before us a nucleus of the original element, or one of the more internal layers. In the vicinity of the bright zone (membrana limitans externa), the nuclei become much less dense. In isolated specimens the nuclei generally are of a spheroidal form.*

The round nuclei which possess the quality of strongly imbibing carmine, are imbedded in the layer of dark granules, and bear the greatest resemblance to the cells generally termed embryonal indifferent round cells. They have a size of 9 μ, show very finely granulated contents, in which as a rule there appear one or more slightly larger particles (nucleoli?). With an accurate focus the minute particles have a bright outline (perhaps identical with the ring around the nucleoli, described by *Auerbach*.† If such a granule be exactly in focus and the object lens screwed a trifle higher, a bright circle is seen

* Whether free nuclei or complete cells had to be dealt with could not always be decided. In some cases I was able to prove positively that the nuclei of the dark layer were surrounded by a very thin protoplasmatic zone.

† *Auerbach:* Organological Studies. Breslau, 1874.

lying inside the line of contour of the corpuscle. These corpuscles have exactly the same appearance as those which have been lately illustrated by *Eichhorst** as the original elements of the spinal cord in man. The homogeneous mass has also almost the same character as is found in *Eichhorst* figs. 2 and 3. Furthermore, in teased preparations we frequently see peculiar forms, such as are represented in *Eichhorst's* fig. 3, and it can be proved, here as well as in *Eichhorst's* plates, that the gray molecular mass with its many prolongations does not form the nucleus, but that the latter exists as a round body, to which some of the intercellular substance adheres mechanically.

In the layer now following, the nuclei are remarkable for their resistance to carmine, contain one or more nucleoli, finely granular contents, and have around each nucleolus a bright ring and a circular outline. Here also a bright line of demarcation presents itself when the tube of the microscope is moved beyond the focus. Between the dark and bright layer, mutatis mutandis, the same difference exists which *Eichhorst* mentions in his treatise;† the light zone containing elements analogous to those to which the author has given the name of clarified (geklärt) cells. The fact may be emphasized that the elements in the retina do not always contain but one nucleolus, which, according to *Eichhorst*, is the case in the spinal cord. The layer of clarified cells (I shall name them as *Eichhorst* does) has a width of 56 μ at the papilla, and gradually decreases toward the ciliary fold β. It terminates at the commencement of this fold, *i. e.*, at that point where later the ora serrata lies. At the same place the fibrous layer ends, and thus there only remains at the future ora serrata the layer of dark corpuscles in a modified form. The elements of the two layers of dark and bright corpuscles, here described, are arranged in a certain radiating manner which even in the thinnest sections is not quite pronounced, so that in horizontal sections the im-

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**Eichhorst:* Virch. Arch. Vol. 64, plate XIII. Figures 1 and 2.
† Loc. cit.

pression is received as if the whole retina consisted of radiating closely ranged sections, directed toward a common centre. In teased preparations it can be shown that the radiating arrangement is caused by fibres, *rf*, passing through the homogeneous substance in which the dark and the bright corpuscles are imbedded.

The bright and dark corpuscles lying in the space between these radiating fibres naturally assume a pretty well-marked radiating arrangement. At the ora serrata the radiating fibres extend slightly beyond the layer of bright corpuscles, which reach nearly to the ora serrata. At this point, the radiating fibres are seen to protrude from the layer of dark corpuscles.

Before I touch upon the fourth, the fibrous layer, a word may be said in regard to a marked differentiation occurring in the layer of clarified cells. The innermost section, fig. 5, of these clarified cells, in close proximity to the fibrous layer, is distinguished by a somewhat darker coloring of the elements, so that the embryonal nuclei are almost as dark as those elements which are turned towards the primary ocular vesicle. The supposition might perhaps be justifiable that these dark elements are the first rudiments of the ganglion-cells.

To the inner side of the layer of bright corpuscles we find a finely fibrous mass, the beginning of the layer of nerve-fibres. These fine fibres originate from the retinal elements, yet it can neither be positively decided what connection they bear to the retinal elements, nor can it be proved that the radiating fibres, *rf*, are the beginning of *Müller's* radiating fibres, nor that they form the continuation of the fine fibrous layer *f*. The layer of nervous fibres protrudes beyond the mass of light corpuscles or somewhat to the inner side toward the vitreous body. The constituents of the layer of nerve-fibres, *f*, are quite short, straight elements, directed perpendicularly toward the vitreous and not easily separable into single fibres. Furthermore we find optic fibres arranged in bundles and radiating from the papilla (fig. 3, *po*.) It can be shown in my specimens that these fibres are not invariably connected with the fibrous layer of the retina formed on the spot, but are often

separated by an interspace filled with a homogeneous mass, fig. 3, *sp.* At other points a few circular fibres are found imbedded, spreading in the homogeneous mass of the inner surface of the retina. These are not sharply defined formations, their borders being slightly indented and irregular, resembling the line of contour of the radiating fibrous layer, fig. 5, *f*, just described. It is possible that these are the nerve-fibres which have entered into a connection with the retina itself.

But the question is, how do the fibres originating in the retina (fig. 5) connect with those fibres coming from the brain and growing towards the retina; or, in other words, how does the connection take place between the single retinal districts with the corresponding brain districts? I shall try to answer this question as well as possible, from my specimens. The union of the fibres must always take place in such a manner that in all individuals identical brain localities become connected with identical retinal localities. This can only happen when the fibrous masses growing from the brain toward the retina on the one side, and from the retina toward the brain on the other side, unite according to fixed laws. The manner of such a union may be represented by the following probabilities. The union takes place either (1) in the eye, or (2) in the brain, or (3) on the way between the eye and the brain. If it occurs outside of the eye, we must assume that compact fibrous masses grow from the retina into the optical papilla, pushing forward toward the brain, along the embryonal nervus opticus originally consisting of cells. Here, in the course of the embryonal nervus opticus, they could unite with fibres coming from the brain. This would constitute a union between the brain and the eye. They could furthermore penetrate into the brain itself and there become blended with brain-fibres. In that case, the connection would take place within the brain. But in the two cases last mentioned, the fibres would grow from the retina and pass into the papilla, that is, a continuous fibrous band, increasing from the ora serrata toward the papilla, would be traced at least as far as the beginning of the optic nerve. But this is not the case, as

fig. 3 shows; we see, on the contrary, on one side of the papilla, fibres growing toward the retina and terminating at *po*, on the other we see very short straight fibrillæ, fig. 5, originating from all points of the retina, standing perpendicularly to the cavity of the vitreous, and ending as if torn. The direction of the last-mentioned fibrillæ is perpendicular to the course of the retina, whereas the fibres originating from the papilla run parallel with the retina. This condition is represented on fig. 4 in a schematic way. Both fibrous systems, those coming from the papilla and those coming from the retina, are united in the posterior section of the retina (fig. 3 *po* and 4). Anteriorly they have not yet met. Therefrom it follows that the fibres are derived from the papilla as well as from the retina, and that they consequently meet within the eye. It is very probable that the fibres furnished by the retina do not grow any further than represented on fig. 5, but that the fibres coming from the papilla grow along the inner line of contour of the retina, till they gradually reach the ora serrata. In such a manner the posterior section of the retina first becomes united with the brain, later the middle, and finally the anterior portion. Experiments were made in order to prove this fact by measurement, but always failed, for the reason that it became impossible to clearly distinguish a marked difference in the extension of the papillary fibres in the two stages under consideration. The mode of connection which we here advocate allows of an approximate conception as to how the theoretically supposed connection of identical retinal points with identical cerebral points is to be imagined in nearly all individuals. It follows from the above-mentioned mode of union that the centrally situated fibrous elements of the cerebral papilla, in all probability, go to the ora serrata, and that the peripheral fibres are destined for the posterior portion of the retina. Consequently it must follow from the same manner of growth in all individuals, that the fibres situated in the centre of the optical papilla are of no importance for the function of sight, while those situated near the periphery are of the greatest importance for the function. In this sense the folds (especially fold γ) gain

quite a different signification; they serve, namely, not only for the formation of single organs (iris, corpus ciliare, macula lutea), but play an important part, since they typically repeat in all eyes the regular connection of the same optical elements with the same retinal elements. Granted that fold γ disappears on the nasal side in mammals without ever playing a permanent part in the organism, it has nevertheless been important in so far as it served to form certain typical connections of the fibres radiating from the papilla with those originating from the retina itself. Although the two stages of retinal development here described are not sufficient to give a systematic picture of the development of the single retinal layers, they suffice nevertheless to offer some fixed points for the genesis of the retinal elements.

1. The development of the nerve-fibres and their union with the optic fibres has just been under consideration.

2. Searching for the genesis of the ganglion cells, it becomes evident that it does not occur by the separation of the lower ends of radiating elements, as described by *Babuchin* in the case of birds and amphibia, but takes place in such a way that in the originally uniform layer of cleared cells the innermost elements take a darker color and obtain other histological characters.

3. Furthermore, as regards the radiating retinal fibres, which in the specimen do not show as distinctly as represented on fig. 5, they are closely packed in the vicinity of the ora serrata, as can be seen on fig. 4. The molecular layer usually covering the ora is absent (not represented on figs. 2 and 3, but has to be looked for at β, fig. 2). But as the layer of dark cells, fig. 5 μ, is still present at this place, the conclusion can be drawn that dark corpuscles and cleared cells need not necessarily be present at the same time. Further it follows that the radiating fibres may exist before the cleared elements can be found. One could suppose that these are the radiating fibres which *Babuchin* considered as *Müller's* fibres, *i. e.*, he thought them to belong to the connective tissue framework. Still it does not appear probable that we have here to deal with the *Müller's* fibres of *Babuchin*, for according to *Babuchin's* figures, *Müller's* fibres develop from spindle-shaped nucleated formations full of pro-

toplasm pointed on both ends, and traversing the other elements at regular distances. What we have under consideration here is a fine mass longitudinally striated, very pale, and irregularly indented wherever it protrudes. It certainly does not possess the peculiarities of a spindle-shaped cell, and can never be mistaken for such. It remains therefore undecided what *Babuchin* meant by radiating elements; at all events, I do not find in mammals anything corresponding to *Babuchin's* descriptions.

Having finished the description of the retina in its first stage, we shall now illustrate its second stage.

In the second stage the thickness of the retina amounts to 250 μ (measured at the distance of 334 μ to one side of the papilla). Consequently, compared with the preceding stage, the whole retina has increased about 20 μ in thickness, and about 10—15 μ in diameter near the ora serrata.*

As regards the single layers, we may distinguish four layers and the tapetum: 1. the layer of dark, 2. of bright corpuscles, 3. of ganglion cells, and 4. the fibrous layer. As to the latter, it has remained quite unaltered, its connection with the fibres coming from the optical papilla seems to have taken place to a greater extent. The layer of ganglion cells, fig. 5 *g*, has become more distinct, and presents itself as a sharply defined zone. The layer of cleared corpuscles has lost somewhat in width (figs. 3 and 5 *m*). Whilst these layers have remained nearly unaltered, and only the ganglion cells appear more distinct, the layer of dark corpuscles (figs. 3 and 5 *n*) shows a new and peculiar arrangement, unnoticed in the preceding stage. It contains at present a central clear part, whilst its two ends are distinguished by a somewhat darker coloring of the elements. The whole layer consists of the same embryonal elements as in the first stage, Fig. 5 μ. Now what does the separation of the dark corpuscles into three layers signify? Is this appearance only transient, or have we now under consideration the separation of the originally single layer of dark corpuscles into three

* We cannot lay much stress upon these measurements, as they were made on folds; it therefore depended upon the observer's estimate whether the measurement was taken exactly perpendicularly upon the axis of the fold.

granular layers, a separation hitherto not described? I cannot answer this positively. Unfortunately, later stages are wanting, and I do not exactly know whether in the said separation into three layers the future granular layers are indicated, or whether the separation is only transient. In the first case, this stage would contain everything necessary for the completion of the retina, apart from the rods and cones, and it were evident that the layer of dark corpuscles divided into the external, middle (intergranular), and internal granular layers, by assuming a darker coloration on two sides, and having a clear middle zone. The latter then would represent the intergranular layer, and the others the external and internal granular layers respectively. But if this be a transient formation, another explanation has to be thought of, and *Wilhelm Müller's** new discovery must be taken into consideration. *Müller* divides the retina into a nervous layer and visual cell layer, and considers the rods, cones, and external granules as belonging to the latter, and all the rest to the former. If this classification of *Müller's* is correct, it must be taken for granted that rods, cones, and external granules are derived from the dark corpuscles of our first stage, which would represent the generators of the visual cell layer. In this case the division of the dark corpuscles into three layers would only be transient, and its significance unknown. Measurements which may throw some light upon this subject are given below, yet they are not convincing, as in the development of the retina two factors must always be considered; 1. the increase of the periphery of the entire globe, and 2. the growth of the single layers. These are two magnitudes whose mutual relation is unknown, and which therefore it is not yet possible to determine with a few measurements. Nevertheless I shall present my measurements and their results. In regard to the dimensions of the single layers I may state that the layer of the dark corpuscles, which measured in the first stage 111 μ, measures 138 μ in the second (of which 5 μ are given to each of the two outer darkened parts). Consequently it has grown 17 μ. In the same manner the layer of light corpuscles,

* *Wilh. Müller:* Anatomical and Physiological Contributions. Leipzig, 1875.

which formerly measured 56 μ, now measures 63 μ, and has grown 7 μ. It must, however, be borne in mind that this layer of light corpuscles is now composed of a strongly and a faintly colored portion, namely of the presumptive ganglion cell layer of 30 μ, and of the molecular layer of 33 μ. On the specimen that I measured, the fibrous layer had lost in thickness; but I would not draw any conclusion from this result, as it is known that the nerve-fibres in rabbits take a peculiar direction from the optical papilla, and do not radiate from the papilla in all directions as in man, but penetrate horizontally as two fibrous bands from before backward into the retina. *Müller's* fibres are no further advanced than on fig. 5; the radiating arrangement of all the retinal elements is plainly visible, especially in the layer of dark corpuscles.

In conclusion let us turn to the description of the membrana capsulo-pupillaris. It is known that it was discovered in 1738 by *Wachendorff*, in 1742 by *Haller*, and in 1752 by *Albin*, that is, three times. It was more accurately described by *Henle* in 1832 and by *Reich* in 1835. To these descriptions have been added since that time but few details concerning the course of the vessels (*Kölliker*, History of Development, 1861; *Lieberkühn*, l. c.). I too am only able to add the following notice regarding the composition of the membrana capsulo-pupillaris. In my first stage nothing is to be perceived of a membrana capsulo-pupillaris. The vitreous surrounds the lens, and is connected in front with the cornea, externally with the choroid. The outer line of contour of the vitreous body passes over into the inner line of contour of the choroid. This inner line later on becomes *Bruch's* elastic choroidal sheath, which latter is nothing else than the membrana limitans hyaloidea of the fully developed vitreous. An inner line of contour of the vitreous in the direction of the lens, from which the future posterior and anterior lens-capsules originate, is already present. At the point of transition of the vitreous into the cornea on the one side, and into the united choroid and sclerotic on the other, a slight obscuration and condensation of tissue appear at about the point *zc*. On fig. 1, this obscuration has not been represented

for the sake of distinctness. It, however, represents the first indication of the zonula ciliaris, which constitutes a projection of vitreous through a retinal slit. The first beginning of the connective-tissue substratum of the iris, and of the membrana capsulo-pupillaris, becomes visible at *i*, fig. 1, and along the anterior circumference of the lens, in a somewhat darker coloring of the tissue of the cranial plates. A plexus of vessels envelops the limiting border of the vitreous and surrounds the lens on both sides. On fig. 1, the lower section only is drawn. In the same manner, the outer border of the vitreous is also surrounded by vessels. (These vessels are also wanting on fig. 1.) Toward the front, the two capillary plexuses become united and form a single vessel, which in the region of the iris-fold ramifies in two directions: one branch takes its course into the subcutaneous tissue in front of the lens, the other branch runs into the choroid along the outer margin of the tapetum, and externally to *Bruch's* elastic membrane. (All these vascular ramifications are not represented.) In the retina itself, I have not been able to perceive any vessels; I can, therefore, neither uphold nor contradict the assertion lately made by *Krause** that the vessels of the retina develop from anastomoses into which enter the original retinal vessels, and the arteria centralis retinæ. In the second stage, the anterior chamber of the eye, fig. 3, *va*, is already formed; the membrana Descemetii is now to be distinguished as a sharp line of demarcation, limiting the cornea posteriorly; this line of contour then passes over to that point where later on the ligamentum pectinatum iridis exists, and forms the posterior boundary of the anterior chamber of the eye, and at the same time the anterior boundary of the membrana capsulo-pupillaris. (Fig. 3, *mcp.*) The posterior boundary of the capsulo-pupillary membrane is formed by the anterior capsule of the lens, which is now more distinctly differentiated, and which passes over from behind into the posterior lens-capsule. Both lens-capsules form the inner and anterior boundary of the vitreous. The vitreous itself is

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*Archives for Microscopical Anatomy by de la Valette and Waldeyer, 1876. Vol. XII., part 4, page 744.

enveloped by two limiting outlines, of which the one, directed toward the lens, forms the posterior and anterior lens-capsules, and the other, directed toward the retina, the membrana limitans hyaloidea. At that point on fig. 1 where the curve β (corpus ciliare) separates from curve α (iris), there remains a small triangular space. Into this space the vitreous sends a spurlike process, which becomes the beginning of the zonula Zinnii, fig. 3, *zc*. Externally toward the retina this beginning of the zonula Zinnii is enveloped by the beginning of the membrana limitans hyaloidea. The membrana limitans hyaloidea reverses outwardly over fold α, and becomes a fine line of demarcation, which covers the inner surface of the united sclerotica and choroid. It is evident that the future elastic membrane of *Bruch*, which is found on the inner surface of the choroid close to the pigment, is nothing else than the outward continuation of the membrana limitans hyaloidea.

Now in regard to the membrana capsulo-pupillaris, all that is necessary to know becomes apparent from what has been said above. It is limited in front by the reversed membrana Descemetii, behind by the anterior lens-capsule, externally and posteriorly by the point of reversion of the membrana limitans hyaloidea into *Bruch's* elastic membrane. In fully developed mammals, *Faber** and *Waldeyer*† have lately discovered that the endothelial covering of the anterior surface of the iris is nothing but the continuation of the reversed membrana Descemetii. But this covering of endothelium is the lateral remnant of the membrana capsulo-pupillaris, persisting in the adult. *Dr. Löwe* has lately demonstrated (Vienna Annual Journal, 1874) that each connective-tissue membrane is formed by two serous covering membranes, which are kept together by a cement substance in which bundles of fibrillæ terminate.‡

* *Faber*, l. c., page 29.

† *Waldeyer*, *Graefe* and *Saemisch*. Handbook of General Ophthalmology, I., 1874, page 227.

‡ This view has especially received its confirmation by *Phix;* but the term "serous covering membrane" was objected to, as it created an erroneous impression, and that a separate and detachable membrane was meant. Especially *Flemming* (*M. Schulze's* Archives, Vol. XII.) objected to the use of this term. It is evident that when most

If this definition of connective tissue is applied to the connective-tissue mass of the eye under consideration, then we have the cornea limited in front in the direction of the epithelium by *Bowman's* membrane, and behind by the membrana Descemetii. These two membranes possess all the characteristics of the serous covering layers. The membrana capsulo-pupillaris is limited in front by the membrana Descemetii, behind by the anterior lens-capsule. Consequently the membrana capsulo-pupillaris has also its two serous covering layers. Finally the vitreous is closed in by the posterior lens-capsule anteriorly, and by the membrana limitans hyaloidea posteriorly, thus being limited by both covering layers. The line of contour of the membrana capsulo-pupillaris is as a rule undulated; slight elevations are found which are directed toward the anterior chamber. These elevations are due to the fact that, in horizontal sections, the vessels which terminate in the membrana capsulo-pupillaris produce, at the point where they have been cut transversely, a spindle-shaped protuberance of the membrana Descemetii, reversed from the cornea upon the anterior surface of the membrana capsulo-pupillaris. Externally the substance of the membrana capsulo-pupillaris continues directly with that of the united sclerotic and choroid. This substance shows close behind folds α and β a changed condition as to its capacity in imbibing coloring matter (carmine). It is evident that in this obscuration of the substance, the indication of the connective-tissue substratum for the ciliary process and for the iris is to be looked for. A distinct separation of the ciliary muscle and the ligamentum pectinatum has not yet appeared.

At the close of this treatise, it is to me a pleasant duty to tender my heartfelt thanks to *Dr. Löwe*, under whose direction I have undertaken these investigations, for his trouble and for his kind instructions.

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delicate connective-tissue membranes are spoken of as being formed by the union of two serous covering membranes and a cement substance, no two removable membranes can possibly be meant. It must therefore be admitted that the term "serous covering layer" is more appropriate than "serous covering membrane," especially as *Löwe* emphatically declares that his serous covering membranes do not necessarily contain continuous endothelium.

TABLE OF MEASUREMENTS.

	1ST STAGE. *Frontal section through the eye of a rabbit embryo of about 3–4 cm.*	2D STAGE. *Horizontal section through the eye of a rabbit embryo of about 6–8 cm.*
CORNEA.		
Diameter of the axis in the centre, . .	86μ	128μ
Parallel to the axis on the right sides, .	66	83
" " " " " " left " . .	66	111
Equatorial diameter measured from the right to the left of the curve, ...	1946	...
LENS.		
Axial diameter in the centre, ...	1066	1139
Anterior lens epithelium, ...	13	27
Lens-fibres, ...	930	945
Posterior albuminous globular mass, . .	123	167
Parallel to the axis on the right sides, . .	619	639
" " " " " " left " . .	619	695
Equatorial diameter from right to left at the level at the roots of eyelids, ...	1084	1195
In the elevation of the beginning of the epithelium, ...	1084	1529
RETINA.		
Transverse diameter from before backward in the elevation of fold α, ...	56	59
Tapetum, ...	26	29
Layer of dark elements, ...	29	30
In the elevation of fold β, ...	86	93
Tapetum, ...	33	39
Layer of dark elements, ...	53	53
On the elevation of fold γ, ...	139	82
Tapetum, ...	19	9
Layer of dark elements, ...	113	66

	1ST STAGE.	2D STAGE.
	Frontal section through the eye of a rabbit embryo of about 3–4 *cm.*	*Horizontal section through the eye of a rabbit embryo of about* 6–8 *cm.*
Layer of light elements, ...	7 μ	ca. 2 μ
Layer of ganglion cells, ...	Not present.	ca. 2
Largest transverse diameter, ...	556	333
Via recta from the entrance of the optic nerve measured to the right, ...	236	250
Tapetum, ...	17	10
Layer of dark elements, ...	120	129
On the external side of the same differentiated darker elements.	Not present.	5
and internal side of the same differentiated darker elements.	"	5
Layer of light elements, ...	53	40
Layer of ganglion cells, ...	Not present.	33
Fibrous layer, ...	39	20
Longitudinal diameter from right to left,		
Internal (nasal side), ...	1668	2335
External (cephalic side), ...	1112	2224
Axis of the eye measured from the centre of the cornea to the centre of the entrance of the optic nerve, ...	1194	1334
Cornea, ...	86	128
Anterior lens epithelium, ...	13	27
Lens-fibres, ...	930	945
Posterior albuminous globular mass, . .	123	167
Vitreous, ...	40	55
Lateral outline of the eye measured from the entrance of the optic nerve along the retina and its prolongation,		
Internal (nasal side), ...	1779	2557
External (cephalic side), ...	1241	2502

EXPLANATION OF THE FIGURES.

(The figures have been drawn from photographs.)

Fig. 1. Transverse section through the eye of a rabbit embryo of about 3–4 cm. in bodily length. Microscope, Schieck; ocular, O; objective, 3, with shortened tube. *tc*, cornea; *lc*, lens; *cw*, corpus vitreum; *gg*, its vessels; *zc*, zonula ciliaris; *e*, protrusion of the corpus vitreum; *r*, retina; *x*, single layer of cylindrical cells; *u*, layer of dark elements; *m*, layer of light elements; *f*, fibrous layer; *t*, tapetum; α, iris-fold; β, ciliary fold; γ, macular fold; δ, papillary fold.

Fig. 2. Left anterior side of Fig. 1, by Schieck's microscope; ocular, O; objective, 5, with shortened tube. *tc*, cornea; *lc*, lens; *r*, retina; *x*, single layer of cylindrical cells; *t*, tapetum.

Fig. 3. Transverse section through the eye of a rabbit embryo of about 6–8 cm. in bodily length. Schieck's microscope; ocular, O; objective, 3. *tc*, cornea; *lc*, lens; *cw*, corpus vitreum; *gg*, its vessels; *zc*, zonula ciliaris; *r*, retina; *u*, layer of dark, and *m*, layer of light elements; *f*, fibrous layer; *t*, tapetum; α, iris-fold; β, ciliary fold; γ, macular fold; *p*, palpebra; *x*, canthus anterior; *mcp*, membrana capsulo-pupillaris; *g*, layer of ganglion cells; *no*, nervus opticus; *po*, nerve-fibres radiating from the papilla; *sp*, interstice between the optic fibres and the layer of nerve-fibres; γ, depression at the point of the right macular fold; *ch s*, indications of the choroid and sclera; *gg* and *gg2*, vessels in the cranial plates.

Fig. 4. *tc*, cornea; *lc*, lens; *cw*, corpus vitreum; *gg*, its vessels; *t*, tapetum; *r*, retina; *no*, nervous opticus. It is to be seen here that the fibres *po* radiating from the optic nerve have already partially reached the radiating fibres, namely at +, whereas at + + they have not yet done so. At the ora serrata, the retina only consists now of the layer of dark corpuscles and of the radiating fibres, whereas the layer of clear cells has already reached its destination. The section is a frontal and not a horizontal section, like Fig. 3; therefore the

folds here are also differently arranged. On the left, the iris and the corpus ciliare are not yet indicated; on the right, on the contrary, they are both present; therefore it follows that iris and corpus ciliare do not begin at the same time in the entire circumference of the eye. Worthy of notice is furthermore the widening shown by the rest of the cavity of the primary ocular vesicle at *pah*.

Fig. 5. A piece of the retina, *m*, Fig. 1, in the vicinity of the papilla nervi optici more strongly magnified. *f*, fibrous layer; *g*, layer of ganglion cells; *m*, layer of light, *u*, layer of dark elements; *t*, tapetum; *rf*, radiating fibres; *n*, limiting seam of the retina; *s*, small elevations of the same; *pah*, cavity of the primary ocular vesicle.

ON SOME AFFECTIONS OF THE OPTIC NERVE.

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Translated by Fred. C. Valentine, M.D.

(Plates XI., XII., and XIII. of Vol. V. Ger. Ed., and Plate V. of Vol. VI.)

[Plate XIII. was published with Vol. V., to which please refer.]

I. Changes in the Optic Nerve in Syphilis.

Syphilis has ever enjoyed most extensive propagation, notwithstanding all manner of hygienic measures which have been devised to oppose its ravages. Thus it does not appear remarkable that the wealth of material offered by this affection was utilized as much as possible for its investigation, which led to the elicitation of that important clinical fact that syphilis may leave its traces in almost every organ ; furthermore, that a certain sequence in the period of the affection of certain organs occurs according to the duration of the disease, and on the other hand, that some organs are more frequently attacked than others, and finally, that definite knowledge was obtained of the histological changes upon which syphilitic processes are based. Thus, literature was enriched by the results of investigations made by reliable authorities.

But, though literature is replete with reports which detail the changes called forth by syphilis in various organs—markedly so in the eye, its retina, choroid and iris—so much more sparse are they in the matter of the changes caused in the optic nerve by the same affection. This is owing perhaps to their comparative infrequency, or to the lack of facilities and occasion for their investigation. A diligent search in literature pertaining hereto brings forth Virchow's* communication, that in brain-syphilis the nerves about the sella turcica, especially the motor

* *Virchow :* Krankhafte Geschwülste, II. 2, page 461.

oculi, abducens, trochlearis, trigeminus, and the optic and olfactory nerves, most frequently participate in the affection; also that, according to his experience, either the nerves become implicated by the meningeal gummosities along which they develop independently, or that the nerves may be found in a mere irritative condition, ordinarily one of a chronic inflammation of the neurilemma or perineurium. These communications are made merely in a general way, and are not accompanied by detailed descriptions of diseased optic nerves.

Virchow's experiences are verified by V. Gräfe's* observations of syphilitic tumors at the base of the brain. In one of these the neoplasm surrounded the optic nerves, spreading backwards along the right nerve, and pressing upon the left as a grayish-red mass, partially permeating it. In the other case, the tumor extended from the pons varolii to the anterior extremity of the optic nerve, filled the sella turcica, penetrated the optic foramina and the sheaths of both optic nerves in such a manner as to leave no perceptible vestige of the nerve-tissue. These reports, as well as the former, lack a description of the histological changes in the optic nerve.

I found such a description in Barbar's† inaugural dissertation, wherein he cites two cases, which I regret I cannot obtain; one of these, by Arcoleo,‡ resembles his (B.'s), and the other by Hulke,§ in which the left nerve alone was affected. In the case discussed by Barbar, under the designation "Neuritis Optica Syphilitica," which presented acute focal affections in the brain and liver, as well as cicatrices on the bones of the skull, the changes in the optic nerves consisted in intense reddening and *unusual thickening*, which caused them to overlap the circle of the foramen opticum, retaining this increase in volume to and through the chiasm. The volumetric differences between the intracranial and orbital parts of the nerves were particularly

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* *Gräfe:* Zur Casuistik d. Geschwülste. Arch. f. Ophth. VII. 2, p. 24. *Gräfe:* Ueber Neuroretinitis, etc., Arch. f. Ophth. XII. 2, page 114.

† *Barbar:* Ueber einige seltenere syphilit. Erkrankungen d. Auges. Zürich, 1873.

‡ *Arcoleo:* 2. Congres periodique international d'ophthal., Paris, and Clinica ottalmica di Palermo, 1871.

§ *Hulke:* Ophthalmic Hosp. Repts., 1869.

striking, their diameter at the cerebral side of the optic foramen being 9 mm., while that of the orbital side was 5 mm.; 8–9 mm. from the introitus scleræ, an ampullary thickening, caused by a sacculated detachment of the external sheath, was found.

A microscopic examination of the nerve showed a dilatation of the interstices between the nerve-bundles, œdematous swelling of the connective tissue, which contained numerous granulation-cells.

The nerve-bundles were replaced by a pap, consisting of granular globules, lymphoid cells, amyloid bodies, and remains of nerve-fibres.

The part of the nerve between the foramen opticum and the introitus scleræ had not undergone such marked changes.

The nerve-sheath bore unequivocal symptoms of perineuritis. The trabecular network which unites the two sheaths was stretched, and its interstices were filled with lymphoid cells, their greatest accumulation being at the inner surface of the outer sheath. On section, the papilla yielded a thickening of the supporting tissue, tensely filled vessels and extravasations. The choroid presented a destruction of its pigmentary epithelium in the vicinity of the foramen.

I cite Barbar's case at length, because both of the cases which I examined present a partial coincidence with his, but also some differences which I shall detail further on.

The first case which was examined was a servant-girl, æt. 25, who had been under treatment a long time for syphilitic ulcers on the hard palate. After these had cicatrized, she died, presenting cerebral symptoms and paralysis of the right motor oculi.

The obduction yielded a remarkable swelling of the brain, especially of the white substance of the right cerebral hemisphere, the anterior part of which was proliferated to such a degree that its inner surface, arching towards the left side, bulged in the inner surface of the left hemisphere.

The corpus callosum was arched upwards, the left ventricle was dilated, while the right was contracted, principally because of a material swelling of its corpus striatum, which had a

remarkably soft feel and was partially agglutinated to the inner wall of the ventricle.

When removing the encephalon from the skull, it became evident that the inferior surface of the right frontal lobe was adherent to the right olfactory nerve, as well as to the right optic nerve, but was separable from them without much effort. The right optic nerve was found thickened to twice its dimensions (fig. 1, plate XI.). The right side of the chiasm was also swelled, and the swelling of the nerve diminished as it approached the optic foramen, thus making it spindle-shaped. It felt rather tough, its pia-sheath was reddened, and its substance of a dull-white color.

A transverse section, magnified by a loupe (fig. 2), shows an increase in the substance of its sheath (*a*), its upper surface appearing as a distinct broad gray border (*b*), and occasionally its interstitial connective tissue becomes more visible (*c*), being palpably distinguishable from the white nerve-substance by its pale-gray coloration. The optic tract is flattened and broad.

The right temporal lobe, which has coalesced with the neighboring dura mater, is remarkably softened, as also is the right gyrus hippocampi, in the substance of which, as well as in that of the islet and in parts of the anterior lobe several pale-gray foci are deposited. These foci arch above the surface of the section, offer a moderately tough feel, and present a few cut vessels centrally. The right motor oculi is flattened and of a pale-gray tint.

The optic thalamus, corpora quadrigemini present no remarkable changes.

In consequence of the cerebral swelling, the inner plates of the skull, especially those of the right frontal and parietal bones, are roughened, and the external surface of the dura mater corresponding thereto is swelled, moist, and of a gelatinous appearance and occasionally suffused with blood. The mucous membrane of the hard palate shows several scars surrounded by an area of injection.

The hymen is intact; neither the genitals and the anus, nor any other part of the body present traces of syphilis.

The specimens obtained were hardened in Müller's fluid and yielded the following, when microscopically examined.

A transverse section of the thickened right optic nerve, when magnified by a Hartnack oc. 3, obj. 7, shows a considerable thickening of its sheath and *marked proliferation* of its interstitial connective tissue (fig. 3, *a*). This is brought about by equally shaped cells, which lie closely together, slightly smaller than the white blood-corpuscles; they have a round or oval nucleus, with somewhat granular contents, and their delicate protoplasm has assumed a partially polygonal shape, because of the manner in which the cell-elements are crowded together. The proliferation of the interstitial connective tissue, as above stated, has pressed the nerve-bundles rather far apart and thinned them. Within the latter, traces of rows of cells (*b*) are seen, as also are solitary ones (*c*), the shape of which entirely resembles those situated in the interstitial tissue.

The above-mentioned rows of cells traverse either the periphery in a transverse direction, beginning in a group of cells, and proceeding either singly or branched, or the central part of the nerve-bundle in a somewhat tortuous course. The nerve-fibres present no remarkable change.

The thickening of the sheath (fig. 4) is caused by an accumulation of cells (*a*), situated between the connective-tissue fibres, as well as in the walls of the larger vessels thereof (*b*), and which can be followed from the sheath into the substance of the nerve. When isolated, these cells appear round, and occasionally oval or polygonal, and sometimes are spindle-shaped.

There is a greater accumulation of cells at the upper surface of the optic nerve than at the lower, which differs from the condition usually stated, viz.: that when interstitial connective tissue becomes the site of cell proliferation, this proliferation takes place only in the course of vessels which are distinctly filled with red blood-corpuscles.

An examination of the *chiasm*, the right half of which is swelled as stated, reveals numerous granular fat-cells in the lamina terminalis grisea, and that part of the third ventricle

which lies above the upper surface of the chiasm is converted into a narrow slit, which, being obliquely turned to the right, traverses the middle of the chiasm, and upon closer examination shows well-preserved epithelium, thickened ependyma, the latter containing numerous brilliant, homogeneous roundish form elements (amyloid bodies).

The neuroglia of the chiasm and the right optic tract presents a marked increase both in quantity and size of its cells, and the vessels there are well surrounded by round cells.

These conditions become more and more diminished the farther back the optic tract is followed, until finally no more abnormalities are found in it, nor in the corp. geniculata, the corp. quadrigeminum, and the optic thalamus.

It is to be regretted that the intraorbital part of the optic nerve could not be examined, owing to the fact that the eyes, which were set aside for a subsequent examination, were lost; thus it could not be ascertained whether the changes observed continue along the whole optic nerve unto its scleral entrance, and whether any changes in the papilla and in the retina would have been observed, all of which is fairly presumable.

Possibly, however, the changes could not be of a very material character, as the subject had manifested no disturbance of vision during life.

The examination of the brain yielded, that its foci of disease, consisted of cells (fig. 5, *a*) which were identical with those found in the optic nerve. They are aggregated mostly about those of the larger blood-vessels, which are filled with red corpuscles (*b*). The vessels, in longitudinal and transverse section, are found imbedded in numerous spindle-shaped cells (*c*).

If the cells be shaken out, a distinct network appears, the beams of which are formed of a fine, molecular, delicate mass (*a*), which contain occasional little heaps of fat-granules (*c*) and shrunken, homogeneous and brilliant ganglion-cells (*f*). At those places, around the before-stated foci, where the cerebral parenchyma begins to soften, granular fat-cells are found (*g*), firstly scattered, then in increasing quantities and in such a manner that at the site of greatest softening they preponderate over the brain-substance.

The larger vessels taken from the diseased portions of brain-substance appear well imbedded in oval or spindle-shaped cells (fig. 6), but there is a deposit of bipolar or multipolar large ganglion-cells immediately proximal to the walls of the vessels.

The walls of the capillaries occasionally contain rather large spindle-shaped masses of protoplasm (fig. 7), which somewhat contract their lumen. The roughness of the inner plate of the skull is explained by an irregular dilatation of the Haversian canals in the form of Howship's lacunæ, in which Kölliker's osteoclasts are imbedded, which are also found in the dura mater, but more plentifully and often connected in a network. The tissue of the dura mater is gelatinous and occasionally permeated by transuded blood-corpuscles.

The *second case* was that of a constable, æt. 42, who had died with manifestations of aphasia and paralysis of the right side of the body. The subject was well nourished and muscular. There was marked swelling of the brain, especially of the left hemisphere, in which the white substance was found to contain several roundish tumors, varying in size from that of a pea to a hazelnut, of a rather uniform pale-yellowish color, their surfaces being attached to the thickened pia mater.

They are bounded by a vascular border of a grayish-red tint, and the brain-matter which surrounds them is softened to such a degree that, when a section is made, some of the tumors become detached. The softening extends through the entire white substance of the left hemisphere, but is greatest at its anterior half.

The right lateral ventricle is dilated. The corpus striatum and optic thalamus are soft; the left lateral ventricle is contracted, especially so is its anterior horn, which is caused by a marked swelling of the corpus striatum and moderate swelling of the optic thalamus. A section of the former shows a tumor, imbedded deeply in its substance, this tumor being about the size of a chestnut, of a knobbed surface, which, like those tumors near the gray-matter layer, on section yields a homogeneous yellowish surface, and also possesses a gray bor-

der. Its lower surface penetrates the left fissure of Sylvius, partly enveloping and compressing the vessels there situated.

A second tumor, somewhat large, but of similar structure, is seen in the region of the lenticular nucleus. The brain-substance is markedly softened about the site of these tumors. The lower surface of the left frontal lobe is found adherent to the dura mater. A view of the under surface of the brain shows a marked thickening of the left optic nerve (pl. XII. fig. 8). It measures 12 mm. at its departure from the chiasm, but diminishes in breadth as it approaches the optic foramen, and there measures 6 mm., thence to be reduced to the size of the right optic nerve. The thickened left optic nerve is of a white color, but is markedly soft.

The entire breadth of the chiasm is 18 mm.; its left half, near the exit of the optic nerve of that side, is markedly swollen, making it appear more arched than the right side.

Both optic tracts are flattened, 7 mm. in breadth; the left runs a straight course, while the right is arched posteriorly, which supplements the above-detailed swollen left optic nerve in giving the chiasm its irregularly distorted shape. The substantia perforata anterior, as well as the flattened pedunculi cerebri, are soft.

Both optic nerves, within the orbits, are equally thick and tough; but a dilatation of their outer sheaths is particularly evident at the entrance of the nerves into the globes, inasmuch as they are somewhat bulged there.

Upon section of the left optic nerve, at the optic foramen, a somewhat larger quantity of a serous fluid escapes from the subdural space than when the right nerve is subjected to the same procedure.

The other organs present no abnormalities; only the left testicle is somewhat reduced in size and very hard, inasmuch as its glandular substance is substituted by callous connective tissue.

There are no scars on the penis nor in the groin, nor are any glandular swellings perceptible.

A microscopic examination of the diseased optic nerve yields an œdematous swelling of the interstitial connective tissue and

of the nerve-fibres, which appear broader and occasionally varicose, and, furthermore, a not very large quantity of granular fat-cells.

The nerve-sheath is also swelled, and between it and the neighboring nerve-substance, similarly to the condition found at the spinal cord in tetanus, a fine molecular mass is deposited; while the pia sheath itself contains heaps of roundish cells, which coincide with the conditions elicited by an examination of the intraorbital part of the nerve, in which longitudinal as well as transverse sections reveal the pia, and especially the subarachnoid tissue, to be permeated by round cells. The longitudinal sections, especially, often reveal the relationship of the cells to the tissue, inasmuch as it is demonstrable that some of the arachnoid connective-tissue bundles are lined on both sides by several rows of cells above described. Furthermore, several bodies concentrically lamellated are found between the other and inner sheaths.

An antero-posterior section through the left globe and optic nerve clearly demonstrates the above-detailed dilatation of the outer sheath, as it also does a swelling of the papilla, which measures 2 mm. in thickness.

I was compelled to defer a detailed histological examination of the eye, because of its not being sufficiently hardened. Should its examination reveal anything of importance, I shall state it in a supplement to this communication.

A microscopical examination of the brain revealed material changes in the vessels in the intercellular substance and in the ganglion-cells. As pertains to the first, it is very manifold.

The adventitia of the finer ramifications of the vessels, isolated from the periphery (fig. 9, pl. XIII.), is irregularly distended by an accumulation of cells which appear round or spindle-shaped, and which occasionally manifest their derivation from the cells proper, by segmentation of their nuclei.

This accumulation of cells is but unilateral in some of the vessels (fig. 10), is increased in others, and especially in the veins, to such a degree that they appear entirely surrounded by cells, and these mostly of round shape.

A transverse section of the calloused white matter reveals the vessels encountered there to differ from those previously mentioned, inasmuch as their variable thickening is caused either by a fibrillary tissue, or more frequently by a uniform cell-proliferation in which all parts of the walls of the vessels participate. The lumen of some of the vessels is clearly seen to be filled by red blood-corpuscles, and others by proliferated endothelium. The conditions detailed in plates 11 and 12 are *sui generis*. Fig. 11 shows the walls of the vessel (*a*) thickened by cell-proliferation, and its contracted lumen plugged by a coagulum. Trabeculæ of fibrillary connective tissue of varying thickness (*b*) radiate from the walls of the vessel, and finally are lost in a circular connective tissue which is suffused with cells (*c*), and forms the outer boundary of the space surrounding the vessel. This space is filled by fine fibres and cells, mostly of a polygonal shape (*d*). At its outer side are a number of irregular roundish cells (*e*).

Fig. 12 shows an oblique section of a larger vessel, which demonstrates that the accumulation of cells occurs principally in the adventitia, and that no material changes have occurred within the elastic membrane.

The intercellular substance of the tough yellowish brain-substance is converted into a callus of fine fibres, permeated by vessels which still conduct blood, and in it occasional fat-molecules are deposited, at the border of which there is a plentiful accumulation of cells which resemble granulations. This occurs principally around vessels the walls of which are permeated by luxuriously proliferated cells.

Some of the ganglion cells are converted into granular fat-cells, corresponding to the softened foci in the brain; while many of them, especially the multipolar ones, have numerous nuclei.

The examination of these two cases shows them both to be affected by syphilitic foci of disease in the brain. Both have considerable swelling of the brain, and in both the base is the most affected; but they differ only by the one presenting a sparsity of foci and those of a more recent date.

Both present diseased optic nerves, and in each the nerve and the brain affection are on the same side.

The diseased nerve is materially thickened in both cases, but the degree of the affection of the nerve is obversely as to the degree of affection of the brain, the one with the sparser and more recent cerebral affections being the most diseased.

This thickening of the optic nerve in the first case calls to mind a communication by Michel,* entitled, " On Hyperplasia o the Chiasm and Right Optic Nerve," which cites the autopsy of a patient æt. 16, who had been affected by elephantiasis of the right leg, and in whom it was accidentally found that the right optic nerve was thickened to the size of a little finger from the chiasm to the foramen opticum, and its increase in breadth even within the orbit to 6–7 mm.; but it was the lower half of the trunk of the nerve in which this was mainly demonstrable.

The prolongation of the nerve-thickening within the orbit, and especially the entire absence of brain lesions, causes this case to differ even macroscopically from those above, but the microscopical investigation of Michel's case, revealing a proliferation of the normal cell elements, a conversion of the finely granular mass probably into elastic tissue, while in the cases communicated the changes in the optic nerve were clearly neuritis and perineuritis.

A comparison with Barbar's case (l. c.) shows a coincidence in the intercranial thickening of the optic nerve, but then a material difference between it and its intraorbital part is perceived; furthermore, that in the second case dilatation of the outer sheath of the optic nerve near the lamina cribrosa is found, and an examination of the intercranial part of the optic nerve shows œdema of the interstitial connective tissue, the formation of granular fat-cells in the nerve, though in small quantity, and finally an accumulation of cells in the pia and arachnoid sheaths.

They differ thus: in the first case, the change in the nerve consisted only in a cell proliferation in the interstitial connective tissue and the sheath; the nerve-substance was not changed; furthermore, in Barbar's case both optic nerves were affected,

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* *Michel:* Arch. f. Ophth. XIX. 3., p. 145, 1873.

in our cases but one, thus classing themselves with those of Arcoleo (l. c.).

These observations furnish new evidence for Virchow's assumption (l. c.), that brain-syphilis involves the optic nerves under the manifestations of neuritis or perineuritis, as also appears thereby that syphilis does not bring about changes in the optic nerves which are peculiar to it alone, inasmuch as similar conditions were found in other affections of the brain and its membranes, as Virchow* details when he found neuritis and perineuritis in parasites in the brain, which provoked a basillar meningitis. Graefe† also mentions this, considering a form of neuritis a consequence of encephalo-meningeal irritation and which he designates neuritis descendens."

Although I have just touched upon the participation of the optic nerves in syphilis, as neuritis and perineuritis, still I must revert to it once more because of a statement which Barbar makes in his dissertation on p. 27. He says: "Our case would serve to support the supposition, that in each of the 4 cases the optic nerve was the first spot diseased."

I must confess that I cannot coincide with this view, but that, because all of the cases reported presented focal affections in the brain (as also did Barbar's case), the conviction is being forced upon me that the disease of the optic nerves is decidedly secondary, called forth by an extension of the affection of the brain to the optic nerves.

I consider this possibility evinced by:

Firstly, that the foci of syphilitic affections of the brain occur mostly at the base and near the optic nerves—this occurs in Arcoleo's case (l. c.) in which the pituitary gland is found to be diseased—in Hulke's (l. c.) communication, in which the gummy tumor lies in the environs of the pituitary gland and sella turcica and extends to the ganglion of Gasser—in Graefe's report (l. c.), according to which the sella turcica is far more involved, and finally in our cases, as detailed above.

Secondly, the anatomical bearings, as detailed by the efforts at

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* *Virchow:* Arch. f. Ophth. XII.

† *Graefe:* Arch. f. Ophth. XII.

injection of Axel Key* and Retzius, who detailed the communication of the sheaths of the optic nerve with the envelopes and serous spaces in the brain.

The position of syphilitic and other affections at the base of the brain, which has such considerable serous spaces, renders the process of extension of a disease to the optic nerve so much more easily comprehensible and offers a ready explanation for the distention of optic sheath, and for the changes in its arachnoid sheath as revealed by the microscope.

Finally the conduct of the blood-vessels deserves a mention, and particularly because much attention has been recently given them, with a view towards a solution of the disputed question, whether they suffer pathognomonic modifications in syphilis or not.

Heubner† arrives at the conclusion, based upon his investigations, that, as has been partially assumed by various authors before him, syphilitic processes are based upon definite changes in the vessels, and that it is the sub-endothelial layer, or that part of the interna which is designated as the internal layer of longitudinal fibres, in which processes of proliferation can be demonstrated, apart from the endothelium. They sometimes project into the artery in the shape of little tumors, and finally contract their lumen and lead to thrombosis or the formation of a new fenestrated pellicle beneath the endothelium, and lead to an obliteration of the vessel.

This process offers much semblance to atheroma, but differs from it by its more rapid development, and because the former is of the character of an hypertrophy, while syphilis is neoplasmic.

Heubner's monograph, plate 1, fig. 1, gives an illustration of the vascular changes, which details the manner in which the neoplasm occurred in the plicated elastic membrane and within which the formation of new vessels took place at the same time.

The assumption of a specific, and, as has been asserted, a preceding change in the vessels, is opposed to the views of Virchow

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* *Axel Key* and *Retzius:* Studien in d. Anatomie des Nervensystems. Stockholm, 1875.

† *Heubner:* Die luetischen Erkrankungen d. Hirnarterien. Leipzig, 1874.

and his adherents, that the vascular change is identical with that of atheroma, and that syphilis only favors an earlier inception of that process.

These divergent views caused me to direct my attention to the vessels in both cases of syphilis, in which the naked eye perceived no changes.

As will be remembered, microscopical investigation of the vessels yielded various results, principally thickening of the vessels, traceable to cell proliferation at their walls.

The proliferation occurs mostly in the adventitia, less frequently in the walls of the vessels, or in the perivascular spaces, or it affects the endothelium.

Thus it is shown that examination of the vessels yields manifold results, that endothelial proliferation can be proven only at isolated points, thus rendering the assertion, that syphilis would manifest itself in this manner before other changes would occur in the brain, perhaps not applicable to all cases.

But the condition of the vessels, as detailed, leads to the discussion of another important question, viz.: the existence of special spaces which surround the vessels, the so-called lymph-spaces.

Various opinions exist on this score. Robin and His believe that the lymph-spaces lie without the adventitia and are bounded by a special membrane, and Kölliker places them within the adventitia.

Though many recent investigators, such as Axel Key and Retzius (loc. cit.), doubt the existence of the perivascular lymph-spaces, most probably considering them artificial productions, I believe that the preceding investigations render the fact of their existence indubitable, inasmuch as I believe that I have obtained true pictures thereof, as delineated in figs. 11 and 13, plate XIII. Especially in fig. 13, a space surrounding a longitudinal section of vessel is seen, this space being filled by nerve-substance replete with cells, and bounded by a delicate membrane, the external surface of which has accumulations of spindle-shaped cells. This arrangement divides and accompanies the ramifications of the vessel. Fig. 11 shows a similar perivascular space, well filled by cells and traversed by perpendicular strips of connective tissue.

These perivascular lymph-spaces impress me as being a material factor in the extension of the disease in syphilis, as in other pathological processes.

II. Endotheliomata of both Optic Nerves.

An examination of the literature pertaining to the occurrence of tumors in the optic nerves leads one to the conviction that these pathological conditions are not very frequent. A majority of the cases examined showed the intraorbital part of the nerve to be the ordinary site of the neoplasms, while its intracranial part was found affected in fewer instances. The neoplasms, in the cases detailed, were found to be mostly connective tissue tumors, most frequently such as myomata, sarcomata, fibromata or gliomata, while neuromata, angiomata and carcinomata were of rarer occurrence.

All of these were unilateral affections, thus showing the synchronous occurrence of tumors at both optic nerves to be of extreme rarity. This may justify the publication of a case, during the autopsy of which the intracranial parts of both optic nerves were accidentally found to be the seat of neoplasms.

The case was that of a char-woman, æt. 55, who had died of granular liver. An examination of the brain showed a small tumor, about the size of a bean, situated at both optic nerves (fig. 1, plate V.).

The tumor at the right nerve lies at its inner side and parallel to it. It is of an oval shape, and is 6 mm. in length by 4 mm. in breadth; of a pale reddish-gray color, of soft consistence, its surface slightly corrugated and here and there very vascular. Its anterior termination extends nearly as far as the optic foramen, posteriorly it almost touches the chiasm, and is so intimately united with the arachnoid sheath of the optic nerve that they can be somewhat lifted off from the nerve, which manifests no evidences of compression.

The tumor at the left nerve differs but slightly from the above and that only in its position, lying as it does at its outer side diagonally to the long axis of the nerve, partly covering

its upper surface and proceeding from the sheath, but leaves no material impression upon the nerve.

When the neoplasms are viewed through a magnifying glass, they are seen to be covered, especially at their bases, by a delicate membrane, which becomes less distinct as it approaches their superior surfaces, there suffering numerous variously sized solutions of continuity, thus being converted into a network, through whose apertures the substance of the tumor protrudes in ball-shaped excrescences. Some parts of this membrane are palpably vascular, the vessels occasionally being visible along the trabeculæ of the network, and occasionally can be followed into the substance of the neoplasm.

When an attempt at section of the mass is made, it disintegrates into small particles, which consist of cells which appear crowded together, of various sizes and spindle-shaped.

To permit an examination, the preparation was placed in Müller's fluid and subsequently the following was elicited.

The membrane which partly envelopes the neoplasm is very vascular in some of its parts (fig. 2, plate V.). The vessels are of varying calibre, some being rather large, while the others, the majority, are small. They are stretched, branch at nearly right angles, which ramify dichotomously and occasionally run a direct or devious course, to form an anastomotic network, with interspaces of varying sizes. In other places their course is markedly tortuous. Their lumen is tensely filled with red blood-corpuscles, and their boundary consists mostly of a light narrow border; some of the vessels, however (*a*), present walls twice the thickness of their lumen, being finely fibrillated or surrounded by spindle-shaped cells.

Besides the vessels, narrow band-shaped, finely fibrillated connective-tissue bundles are also visible; these run a partly stretched and partly tortuous course (*b*), and are either naked or surrounded by numerous cells.

A considerable number of large round bodies (*c*) are seen about the vessels and the above-mentioned bundles of connective tissue; but mostly at the sides of or covering the vessels. These bodies are surrounded by a bright margin, and are com-

posed of a number of layers, concentrically arranged. They inclose, within a finely granular mass, several granule-like bodies (*d*), or are filled with a homogeneous substance which refracts light strongly.

Numerous cells fill the interspace between the vessels and the bundles of connective tissue, which cells predominate to such a degree in the lower layers of the neoplasm that they make up its greater bulk, while the vessels are materially diminished in number.

An examination of a lower layer of the neoplasm, under a Hartnack ocular 3, and objective 7, shows it to be composed of spindle-shaped cells, closely crowded together (fig. 3, plate V.), with delicate contour, and as the cells at the margin of the preparation show, their finely granular protoplasm proceeds from them in fine short processes. All of the cells have an oval, clearly contoured nucleus, with somewhat granular contents. In rather numerous places these cells surround nuclei or cells, imbedded in a fine molecular mass, in layers like those of an onion, thus somewhat resembling the arrangement of the cell elements in epitheliomata.

If the cells be isolated (fig. 4), and examined under high power (immersion 10), it becomes patent that those cells which at first appeared as spindle-shaped, are of various sizes, smooth, with protoplasm especially delicate in the larger ones, causing it to appear as a fine pellicle, in numerous variations, thus producing the impression of fibrillation or ramification.

Many of these cells have degenerated into a delicate pellicle, containining oval nuclei which become more or less distinct upon staining with picro-carmine (fig. 5, plate V.).

The sparse vessels which course within the tumor, present numerous spindle-shaped cells in their adventitia (fig. 6), which closer examination reveals to be traceable back to a cloak-like envelope by the above-mentioned flat cells.

The optic nerves, viewed microscopically, present nothing notable except the presence of concentrically lamellated bodies in its sheath.

According to these investigations, the neoplasms at both optic

nerves consist of flat cells, resembling endothelium, but differing therefrom, being materially larger and resemble epithelioma because of their partly concentric arrangement, and furthermore, as they present incipient and completed sandy formations, they bear a resemblance to tumors of the dura mater which have been designated as psammoma, sarcoma, epithelioma or endothelioma.

These differences in designations meet a partial explanation in the fact that some attach greater importance to the presence of the bodies of sand, while others employed too feeble powers to permit a correct judgment of the shape of the cells; furthermore, it is only the more recent investigations which permit a knowledge of the histological structure of the connective-tissue cells and their relation to endothelium, as also the normal structure of the sheaths of the central nervous system.

An examination of literature on the histology of psammoma permits two principal forms thereof to be distinguished; firstly, one wherein sandy formations of various shapes and sizes are imbedded in a tissue which consists principally of a connective tissue, whose fascicular bundles cross each other; and, secondly, the form in which the greater part of the tissue is composed of cells, which are either round or spindle-shaped, and are described as resembling epithelium or endothelium.

The first form, which corresponds to the type as established by Virchow, has been described by him,* by Steudener† and by Arnold,‡ while Lambl § considers the last described neoplasm which consists of cells, a sarcoma; Robin‖ describes it as endothelion, as also does Golgi.¶ The merit of somewhat clearing up these divergent views pertains to Neumann of Königsberg, in his dissertion "On Sarcomata with Endothelial Cells,"** wherein he proves that if the proper method of inves-

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* *Virchow:* Krankhafte Geschwülste, Vol. II.

† *Steudener:* Virch. Arch., Vol. L. ‡ *Arnold:* Virch. Arch., Vol. LII.

§ *Lambl* and *Löschner:* Franz Josef Kinder-Spital, Prag, 1860.

‖ *Robin:* Journal de l'Anatomie et de la Physiologie, 1869.

¶ *Golgi:* Sulla struttura e sullo sviluppo degli Psammomi. Paris, 1869.

** *Neumann:* Arch. d. Heilkunde, Vol. XIII., 1872.

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tigation be employed, the apparently finely fibrillated base of many psammomata can be demonstrated to consist of cells which form delicate, thin, transparent plates, resembling endothelium (thus corresponding to the observations of Robin and Golgi), and whose characteristic peculiarity consists in a tendency to plication, and, furthermore, have a strong inclination to rest upon their margin, thus rendering them easily mistakable for spindle-shaped cells. Contrary to Golgi's proposition, to call these tumors endotheliomata, Neumann designates them as sarcomata with endothelial cells.

If the histological structure of the site of the development of the neoplasm in the case reported be considered—I allude to the arachnoid sheath of the optic nerve, as detailed by the most recent investigations of Axel Key and Retzius*—it is seen that it lies loosely against the nerve previous to its entrance into the canal, and consists of a delicate network of connective-tissue bundles, which cross each other in various directions, and has pellicular cells imbedded in its interstices, which clothe the upper and lower surfaces of the trabeculæ, and cover those which proceed from the latter to the pia-sheath as subarachnoid tissue, forming their endothelial sheath.

If we consider that many arachnoid sheaths, even those of children but a few days old, as I have had repeated occasion to ascertain, frequently have concentrically lamellated bodies, cylindriform sand formations amongst the narrow bundles of connective tissue of the arachnoids, and that envelopes of groups of cells, in onion-like lamellation, are not rare, then we can unhesitatingly explain the production of the neoplasms on the score of proliferation of these structures, which are normal, to the arachnoid. Conditions of imitation must be assumed, as was laid down by Ludwig Meyer,† as they often bring about material proliferation of the elements of the arachnoid. In view of the above conception of the origin of the neoplasms, I consider endothelioma a justifiable designation for them, because

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* *Axel Key* and *Retzius:* Studien in d. Anat. d. Nervensystems, 1. Heft. Stockholm, 1875.

† *Meyer:* Virch. Arch., Vol. XVII., p. 859.

the epithelial cells materially preponderate in their structure. Inasmuch as the sand formations coincide with that which would be normal if in a minor degree, I consider myself also justified in looking upon them as having proceeded from the cells.

An examination of various communications on psammoma would cause Virchow's observation (loc. cit.) to appear authoritative; *i. e.*, that psammoma develops either as an hyperplasia of such parts, which normally contain much sand, or heteroplastically, and then in various parts of the dura mater and arachnoid, in the neighborhood of the infundibulum and pons Varolii.

Two communications deserve particular attention in this connection, as they both contain a reference to neoplasms on the optic nerves.

One by Steudener* describes a tumor (psammoma) the size of a cherry, which proceeds from the dura mater, rests upon the external part of the foramen opticum, causing a flattening of the optic nerve; the other by Neumann† describes that rare condition, wherein a psammoma, the size of a walnut, embracing the intraorbital part of the optic nerve, produces a nuclear proliferation of the perineurium of the latter.

Thus, in the first case, the involvement of the intracranial part of the optic nerve is owing solely to its proximity to the tumor which proceeds from the dura mater; while in the other, though the tumor proceeds from the sheath of the optic nerve, it takes its origin from the intraorbital part thereof. The affection is unilateral in both cases; while, as appears by the preceding communication, the neoplasm, which is developed upon the arachnoid sheath of the intracranial part of the optic nerves, affects both sides.

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* *Steudener:* Virch. Arch., Vol. L., p. 223.

† *Neumann*. Arch. d. Heilkunde, Vol. XIII.

EXPLANATION OF FIGURES ON PLATE V.

Fig. 1. Chiasma and tumors of both optic nerves. Natural size.
Fig. 2. Vessels of the membrane investing the tumor: (*a*) vessel with broad adventitia; (*b*) connective-tissue bundle of the arachnoid; (*cd*) formations of sand. Magnified 320.
Fig. 3. Section through a deep layer of the tumor: (*a*) spindle-shaped cells with branching protoplasm; (*b*) concentric arrangement of cells. Magnified 320.
Fig. 4. Isolated cells of the neoplasm. Immersion 10.
Fig. 5. Union of cells forming a membrane. Immersion 10.
Fig. 6. Isolated vessel with numerous cells.

PLATES XI., XII. AND XIII.

Fig. 1. View of inferior surface of thickened right optic nerve, natural size.
Fig. 2. Transverse section of thickened optic nerve. Slightly magnified.
Fig. 3. Transverse section of thickened optic nerve: (*a*) cell proliferation in the interstitial connective-tissue; (*b*) rows of cells within the nerve-bundles; (*c*) isolated cells. Magn. 320.
Fig. 4. Transverse section of thickened sheath: (*a*) cell proliferation in the sheath; (*b*) in the walls of the vessels; (*c*) in the connective-tissue septa. Magn. 320.
Fig. 5. Section of brain-substance: (*a*) cell proliferation; (*b*) transverse section of a vessel filled with red blood-corpuscles; (*c*) spindle-shaped cells in the walls of the vessel; (*d*) network; (*e*) accumulation of granular fat-cells; (*f*) ganglion-cells; (*g*) granular fat-cells. Magn. 320.
Fig. 6. Isolated vessel with copious cell proliferation.
Fig. 7. Capillary vessel with large cells in its walls and contraction of its lumen.
Fig. 8. Inferior surface of chiasm.
Figs. 9 and 10. Blood-vessels of brain-cortex with cell-proliferation in the adventitia.

Fig. 11. Transverse section of a larger vessel with thickening of its walls, *a*, from which trabeculæ of connective-tissue, *b*, radiate to the limiting wall, *c*, of the perivascular lymph-space, *d*, which is filled with cells and has on its outer surface a coating of proliferated cells, *e*.

Fig. 12. Oblique section of a large cerebral vessel, showing cell-proliferation outside of the elastic membrane.

Fig. 13. Perivascular lymph-space, bounded externally by a distinct delicate membrane which is covered by cells.

A CASE OF OSSIFICATION OF THE CHOROID WITH THE OPHTHALMOSCOPICAL APPEARANCES.

By Prof. LAQUEUR, of Strassburg.

(Plate I.)

Translated by Dr. C. Williams, of New York.

A man, 36 yrs. old, strong and healthy, consulted me on the 6th of February, 1874, on account of disease of his right eye. Sixteen years before he had lost the sight of the eye, without being able to assign a reason for it. At any rate, there had not been any considerable inflammation of the eye. For many years he had remarked a white spot in his eye, but otherwise he had had no cause of complaint.

The day before coming to me, and during severe muscular exertion, he had a peculiar and an unpleasant sensation in his right eye, and immediately afterwards it was observed that the "white spot" had changed its position and its form. An examination disclosed that a somewhat shrunken, yellowish cataract had fallen into, and its lower edge had become wedged in the inner angle of the anterior chamber. The anterior surface of the cataractous lens impinged upon the posterior wall of the cornea, while its upper portion was upon a level with the upper margin of a tolerably narrow pupil.

There was, however, an appreciable space between the lens and the pupillary margin of the iris. Some brownish specks were still attached to the posterior wall of the cornea, at a point above the upper edge of the cataract. (Evidently some fragments detached from the cataract.)

For the rest, the eye was remarkably free from irritation; a slight subconjunctival congestion only was barely discernible.

The pupil, as stated, was almost entirely closed by the cata-

ract. The striations of the iris were plainly visible. The iris, however, trembled very freely with the slightest movement of the eye.

Palpation in the ciliary region showed the tension of the eyeball to be much diminished (—T2). There was not the faintest perception of light. Patient does not complain of any pain. The left eye is normal in every particular.

Under these circumstances, two lines of treatment may be adopted. The cataractous lens which lies in the anterior chamber, it is true, may not occasion any complaint at present, but may at any time cause the supervention of an iritis or irido-cyclitis, and, at all events, should be removed. On the other hand, this eye, so long useless for visual purposes, may set up sympathetic irritation in the other eye, and the safest plan would be to enucleate it, and this operation was proposed to the patient, who, however, would not consent to this, but readily agreed to extraction of the lens.

The operation was performed on the 10th of February. An incision of sufficient breadth having been made at the periphery of the cornea, an attempt to press out the lens was made. The effort not being successful, a small Critchett's spoon was introduced, and the lens extracted without difficulty or the escape of vitreous. The cataract proved to be tolerably hard, flattened, and small; cortical matter was present in very small quantity. A critical examination of the cataract was unfortunately not made, but no considerable chalky deposit was observed.

Immediately after the extraction, the cornea collapsed, and became corrugated as only seen in senile individuals, which in this case occasioned me much surprise.

It was still more remarkable that the cornea remained sunken and wrinkled after the lapse of a quarter of an hour, instead of assuming its normal curvature and lustre within a few minutes, as is usually the case. We were obliged to bandage the eye in the condition described.

The wound healed promptly, the cornea assumed its natural curvature and the anterior chamber had filled at the end of twenty-four hours. Still there remained for a long time a

moderate degree of irritation, insomuch that it was not thought well to discharge the patient before the end of three weeks. A short time before the patient was sent away, an examination was instituted, in order to determine the original cause of his disease, and the following is the result.

The eye is free from irritation; shape and movements of of the eyeball perfectly normal. The pupil is round and reacts synchronously with the pupil of the other eye. The pupil appears of a jet black, yet in certain positions of the eye a light reflex is obtained, resembling that characterizing some intraocular tumors. The ophthalmoscopical examination demonstrated the refractive media, including the vitreous, to be perfectly clear. Still there became apparent at once a peculiar whitish reflex, which in some places was brilliant, and presented the same characters in the direct as in the inverted image. *Absolutely nothing in the slighest resembling either the papilla, the retina, or any of its vessels, or any choroidal vessels could be seen.* It is true, a few fine red lines were seen in the lower, and lower and inner quadrants of the retinal region, but whether they could be considered as blood-vessels is very doubtful.

Examination with a strong convex lens revealed the entire background as a *light markedly concave surface*, which showed no changes of position or any tremulousness with the movement of the eye, and which reached as far forward as could be seen through a dilated pupil, and certainly farther forward than the equator.

At the region of the papilla might be seen running upwards and outwards, inwards and downwards, indications of radiating striæ. This region is, furthermore, surrounded by a zone of serrated spots, which seem to project a little above the concave surface of the interior. Outwards and upwards are some groups of vividly brilliant points, which are recognized as cholesterin plates. A few of these little brilliant spots are also seen at other parts of the periphery. Finally, toward the extreme periphery might be seen a brilliant white surface, which, in some places gradually, in others abruptly, merged into a grayish-white surface, an undulating line marking the two borders. These very

unusual appearances could not be explained upon the basis of any of the known ophthalmoscopical appearances. Detachment of the retina was not to be thought of, or an intra-ocular tumor, for the white background did not project into the eye at any place.

The supposition of some morbid change of the entire retina would not explain the absence of the papilla. The peculiarly rigid and immovable ophthalmoscopic picture awoke in me the thought that perhaps I had to do with a bony shell of the background of the eye, although, as far as my knowledge extends, such a condition has not heretofore been observed with the ophthalmoscope. In order to put this idea to proof, I examined the eyeball anew by palpation, and was not a little surprised to find that, as far back as could be reached with the fingers, the entire posterior segment of the globe was as firm and resistant as bone, while in a zone of variable width from the cornea and on the cornea, the tension was greatly diminished, —3. The border of the bony formation could be felt with perfect distinctness in the upper portion of the globe; the palpating finger felt (through the upper lid) the sharp bony edge, which about corresponded with the equator of the eye; laterally and below, the anterior border of the ossification could not be felt so plainly.

Slight pressure in the ciliary region with a blunt probe readily caused pitting, while pressure applied posteriorly to the equator produced no visible depression, but readily induced motion of the entire eye. The eye, then, is a phthisical one, and had it not been for this partial ossification, it had presented the ordinary appearance of an atrophic bulb.

After his discharge, the patient continued to present himself at long intervals, but the conditions, as described in the foregoing, had not changed in the least up to October, 1876. The appended drawing, made by my assistant, Dr. Wilbrandt, in October of last year, very faithfully illustrates the details of the background, except that the very striking concavity of the ophthalmoscopic picture could not be reproduced in the drawing, and the shading of the striations is too heavy in some places. The middle of the

picture, from which the radiating lines begin, corresponds to the region of the papilla, and the points which lie to the right and above should have been depicted as much more brilliant than they appear in the drawing. The network of dark lines, which includes a great part of the background, probably consists of band-like elevations, which project more or less everywhere, but nowhere very prominently into the cavity of the eyeball. Whether the snow-white zone at the periphery belongs to the ossified portion or not, I could not absolutely determine.

The ossification, as here proven, explains the phenomenon observed at the operation, viz., the unusually well marked and long continued collapse of the cornea.

Under ordinary circumstances, it is well known that the cornea does not shrink during an operation for cataract in young persons.

The vacuum which would otherwise be caused by the loss of the aqueous humor and the extrusion of the lens is compensated for by the bulging forward of the vitreous, and the cornea remains arched. But by what agency is the vitreous to be forced forward? Is it through concentric contraction of the elastic sclerotic diminishing the calibre of the globe in all directions, as has heretofore been universally held, or as taught by Arlt (Graefe and Saemisch, Handbuch, Bd. III. p. 273), by means of the action of the muscles surrounding the eye, especially the orbicularis palpebrarum, which drives the vitreous forward? Whichever of the two theories may be the true one, the cornea must collapse in every such case as this, for the sclerotic cannot of itself contract because of the rigid base which prevents it, and the same cause renders inoperative any pressure from muscular contraction, which would otherwise be transmitted through the sclerotic to the vitreous.

As to the origin of the ossification, it is worthy of note that it developed in an eye which had never been the seat of any acute inflammatory process, and that its progress was slow and unnoticed. There must have preceded an insidious choroiditis, which, save the loss of sight, gave no sign. The complete integrity of the iris and the ciliary region favors the

opinion advanced by Knapp (Archives of Ophthalmology and Otology, vol. II., 1. page 133) that the capillary system of the choroid is the place of origin of osseous tissue in the eye.

Again, as to the question of how the vitreous is nourished, this case is one of some interest. According to a widespread belief, the vitreous is nourished by the vessels of the choroid, the nutrient fluids passing through the retina. Now here by far the greater portion of the choroid, together with the retina has undergone bony degeneration, therefore unfitted for the nourishment of the vitreous, although the eye was filled with fluid, and the vitreous clear and transparent, and in any event participating in the tissue changes. Does this not justify the assumption that the vitreous in this (and perhaps in any) case is nourished by the vessels of the *ciliary body?* And the facts here are in accord with the condition so often found, *i. e.*, that in cases having most marked choroidal changes, there may be an entirely normal vitreous, while in chronic affections of the ciliary body, opacities of the vitreous are very rarely absent.

The *role* which the ciliary body plays in the nourishment of the eye is unfortunately, up to the present, but imperfectly known. To the entire integrity of the ciliary body is without doubt to be attributed the escape of the left eye from any form of sympathetic disease. *Knapp* (l. c.) and other authors explicitly call attention to the fact that ossification of the choroid does not *per se* predispose to sympathetic affection of the other eye, but that this result is brought about by inflammatory complications on the part of the *ciliary body.* The question may arise, Had we to deal with a real bone formation, or was it perhaps only a chalky exudation in the foregoing case? Chalky depositions in the eye are found, in their most diverse forms, as the result of retrogressive metamorphoses, and they may—according to *Knapp*—be diagnosticated where an advanced degeneration of the iris and a chalky lens are met with in a phthisical eye. Neither of these conditions were present in our case. Although the lens was not minutely examined, of one thing there is no doubt, it was not bony. In addition, those hard, shell-like masses in the background of the eye are almost, with-

out exception, regarded as transformations. While it is true that ossification and calcification often coexist in the same eye, we readily admit that possibly the white peripheral portion of the fundus may be due to calcification.

It is sufficiently well-known that new formation of bone is frequently met with in the anatomical examination of eyes that have been enucleated. We owe much to the valuable labors of *A. Pagenstecher* (A. of O. VII., 1. p. 98–118), *Knapp* (l. c.), and *H. Schiess* (A. of O. XIX., 1. p. 202–220), who within a recent period have contributed so much to the elucidation of this condition. The place of origin of the bony tissue has been especially discussed by them. However, an ophthalmoscopical examination intra vitam of the eyes that formed the subject of these labors was, on account of the changes in all the refractive media, entirely impracticable.

Through a combination of happy circumstances in the foregoing case, the bony shell of the fundus was, through the ophthalmoscope, rendered accessible to the eye, and upon this ground the communication of the case seems to be justified.

THIRTEEN CASES OF OCULAR TUMOR, WITH A CASE OF TUMOR OF THE OPTIC NERVE, AND A CASE OF PANOPHTHALMITIS WITH A CLOT SIMULATING A TUMOR.

By Dr. E. L. HOLMES, of Chicago.

With the Microscopical Description of the Specimens by Dr. H. Knapp.

It has fallen within my experience to observe sixteen cases glioma, eighteen of choroidal sarcoma, three of sarcoma of conjunctiva, one of sarcoma of the iris, one of sarcoma of cornea and sclerotic, two of epithelial cancer of cornea and sclerotic, three of enormous fungus hæmatodes, three cysts of the iris, one peculiar cystic tumor under the tendon of the internal rectus of an atrophied globe, one large fibrous tumor of the cornea and sclerotic, and a remarkable case of congenital tumors on the papillary border of each iris, like the "corpora nigra" so often seen in the horse—reported in the transactions of the Illinois State Medical Society, 1873.

These tumors were observed in hospital and private practice, in an aggregate of somewhat more than twenty thousand cases of diseases of the eye.

The following cases have come comparatively recently under my observation. Case No. 7 is somewhat remarkable, as exhibiting so little disturbance in the anterior portion of the globe, even when inflammatory symptoms had been violent.

In only one instance have I been able to trace hereditary tendencies in the patient.

In every case in which I have removed glioma, I have either been informed of the death of the patient, or of the extensive return of the disease in the orbit. In only one case of extirpation of the globe for sarcoma have I ever heard of the death of the patient. In this case, malignant growths were found at the end of two years in the liver, mesenteric glands, brain and orbit.

No. 1. Choroidal Tumor.—Mr. ——, æt. 43 years, began to suffer in March, 1872, from central scotoma of right eye, which gradually extended till vision was totally destroyed. The eye became painful about the middle of February, 1874. On the 6th of March following, I found the globe tense and very painful—lens cataractous—pupil dilated and the anterior chamber obliterated. For these symptoms extirpated the eye.

A white soft tumor, the size of a French bean, occupies the posterior part of the vitreous chamber. The centre of its posterior surface is firmly united to the sclerotic, the lateral borders are connected with the choroid, the inner layers of which cover the whole tumor. The retina is detached in the shape of a funnel. The tumor consists of small white spindle-shaped cells, closely packed together. *Anatomical Diagnosis: White small spindle-celled sarcoma of the choroid.*

No. 2. Choroidal Tumor.—Mr. L. R., æt. 62 years, first observed, two years ago, a large central scotoma in the left eye, which appeared quite dark by day and reddish by night, and gradually extended over the whole field of vision. Three months ago pain became a most prominent symptom, which no remedies of the family physician could relieve. The eye was extirpated May 1st, 1877, the globe being very tense, pupil dilated, iris discolored and very near the cornea, lens opaque.

The vitreous humor was transformed to a yellowish serum.

The posterior part of vitreous chamber is occupied by a roundish tumor, the size of a cherry, with a nodular surface. The tumor consists of two portions about equal in size, the one white, the other mottled white and black. The growth encircles the optic nerve. The retina is absent. The choroid, as far as it is not occupied by the tumor, and the ciliary body are healthy. The structure of the growth is that of a *round and spindle-celled melano-sarcoma.*

No. 3. Choroidal Tumor.—Mrs. B. O., Irish, æt. 75 years, submitted to extirpation of right eye, Dec. 8th, 1875. She stated that four months previous to this date, she accidentally discovered that she could not see with the eye. After another month, the patient began to suffer pain, which continued with great severity three months, when she

applied to me for aid. The globe was very tense—conjunctival vessels enlarged, anterior chamber filled with blood.

A blackish-gray, uniformly granular, softish substance reached from the optic nerve, which was not invaded, to the iris, filling more than half the globe. It began abruptly in the choroid, was on its inner surface covered by the pigment epithelium, on its outer by the lamina fusca, which could be detached from the sclerotic. Its substance consisted of white and pigmented round cells of different sizes, imbedded in a scant striated matrix.

Anatomical Diagnosis: Round-celled melano-sarcoma of the choroid.

No. 4. Choroidal Sarcoma.—Miss H., æt. 23, enjoying good health, had observed for eighteen months a gradually increasing diminution of vision in the upper portion of the field, when she came to me Nov. 12th, 1872, with the eye in the following condition:

In the lower portion of the left globe, just behind the iris and lens, could be seen with the unaided eye a tumor, resembling in form and color a cataract displaced downward. By means of the ophthalmoscope the tumor could be seen extending quite far posteriorly, although the lens and vitreous were somewhat cloudy.

There was a slight perception of light in the remaining field of vision.

The anterior chamber was obliterated, the pupil moderately dilated, but there was no increase of tension nor pain. The lower portion of the ocular conjunctiva was marked by the presence of several very large and tortuous vessels. The globe was extirpated at the above date.

A hemispherical grayish-black tumor, the size of a large cherry, occupies the region from the front part of the ciliary body to the equator of the globe. Its inner surface is smooth, the outer intimately connected with the sclerotic. The ciliary muscle and the ciliary processes have completely disappeared. The growth touches the posterior surface of the iris. The iris, and the parts of the ciliary body and choroid which are not occupied by the tumor, are healthy. Under the microscope the growth manifests itself as a *round and spindle-celled melano-sarcoma.*

No. 5. Choroidal Sarcoma.—Mr. W. L. D., æt. 47, bookkeeper, consulted me Dec. 3d, 1874, stating that he had always enjoyed excellent general health. Twelve years ago, he lost the sight of the right eye without known cause, although the globe continued to appear normal. Two years ago, there began to be considerable periodic pain and inflammation in the eye almost every month. During the last eight months and a half, the pain was excruciating and almost constant.

I found the pupil closed, the cornea somewhat vascular, the anterior chamber obliterated, the globe very tense.

I expressed the opinion that there was either a choroidal tumor, or simple glaucoma, following iritis. The globe was extirpated without delay.

A white, soft tumor, the size of a large cherry, was posteriorly in intimate connection with the sclerotic; more in front the choroid seemed to insert itself into the tumor, its inner layer covering a part of its periphery. The retina was absent. Upon the ciliary body lay a soft, somewhat cheesy substance, consisting of a grumous material, red and white blood-corpuscles, pigment in various forms. The tumor consisted of small, white, round, oval and fusiform cells, imbedded in a scant, finely granulated matrix.

Anatomical Diagnosis: Glio-sarcoma of the choroid.

No. 6. Choroidal Tumor.

The notes regarding this case were unfortunately lost.

The specimen is a fine *round and spindle-celled melano-sarcoma of the choroid*, which rises abruptly over the level of this membrane, is hemispherical in shape, the size of half a cherry, with a smooth, somewhat uneven surface. It occupies one side of the choroid, from near the optic nerve to the smooth part of the ciliary body. The retina is detached in the shape of a funnel. The other tissues of the globe are normal.

No. 7. Choroidal Tumor.—Mr. S. P., 32 years of age, consulted me May 16th, 1876, giving the following history. Three years ago, he accidentally discovered that his left eye was nearly blind. In eighteen months, all perception of light had vanished. Two months ago he was seized in the night with a most agonizing pain, which continued a week,

when the upper portion of the eye became dark-colored and staphylomatous.

At the above date, I found a very large staphyloma of the choroid and sclerotic. The pupil was much enlarged, regular and black, the iris brown and apparently not discolored, the anterior chamber was remarkably deep, the conjunctiva but slightly congested.

There was a small central opacity of the cornea.

The globe, although considerably enlarged, was not more tense than normal.

No view of the fundus could be obtained on account of the presence of a very dark yellowish-brown fluid, as revealed by the section of the globe. I did not suspect the presence of a tumor.

The father of this patient's mother died from the effects of a "cancer of the nose."

A mottled black and white, hardish tumor reaches from the immediate vicinity of the optic nerve to the ciliary region, filling half the eyeball. Its inner surface is even and black, the outer firmly connected with the sclerotic. The retina is detached in the shape of a funnel; the optic nerve is healthy. The tumor consists of white and pigmented round and spindle-shaped cells of different sizes, with large and distinct nuclei and nucleoli. Matrix scant, granular. The white portions of the tumor, as a rule, contain round cells, the black portions show stripes of pigmented spindle-shaped cells. *Anatomical Diagnosis: Round and spindle-celled melano-sarcoma of the choroid.*

No. 8. Choroidal Tumor.—Mr. W. B. M., 35 years of age, had a severe attack of conjunctivitis in his tenth year, which left the vision of the right eye very imperfect. Seventeen years after this, he received a blow on the same eye, which caused for a year a chronic inflammation. Till within three years the eye was normal in appearance. The globe then began to enlarge, and became very painful.

At the first visit to me, Feb. 7th, 1877, there was a very large staphyloma of the upper and inner portion of the sclerotic, near the equatorial section of the globe. The cornea was also staphylomatous, but so changed in appearance that its outline was scarcely traceable. The globe was still quite movable.

It is worthy of notice that the tension was not increased, although

near the equator the tip of the finger could feel an exceedingly hard ridge, which proved, on examination of the specimen, to be a calcareous degeneration of the choroid.

The globe was elongated in its antero-posterior direction, and completely filled by a white, soft, coherent, fibrous substance. In the posterior part, this substance was surrounded by the outer layer of the choroid, which could be detached from the sclerotic. The iris and ciliary ligament on one side of the specimen were preserved, but on the other wholly destroyed by the pseudoplasm which, on that part, was in intimate connection with the thinned sclerotic and cornea.

In the outer layer of the specimen were numerous chalky deposits. The retina and lens were not traceable. The optic nerve outside the eye was macroscopically and microscopically normal. The substance of the pseudoplasm in some places consisted of a striated matrix, in which numerous small round and oval cells were imbedded, in other places fusiform cells with short and long offsets were predominating. *Anatomical Diagnosis: Round and spindle-celled sarcoma of the choroid.*

No. 9. Choroidal Tumor.—Mr. E. H., Irish, 40 years of age, in excellent health, was examined by me in Nov., 1874, for impaired vision of the left eye, which was first observed, five weeks before, as an extensive scotoma of the left portion of the field of vision. The presence of a tumor was easily recognized as a dark abrupt elevation projecting from near the middle of the nasal hemisphere. Immediate extirpation of the globe was urged. The patient, however, delayed till the following March, when the terrible pain made him willing to submit to any means of relief. The pupil was moderately dilated; the anterior chamber totally obliterated. The vitreous had become so opaque that at this time the ophthalmoscope could not aid in making a diagnosis.

A black lobulated tumor reaches from the vicinity of the optic-nerve entrance to the lens, which is compressed and pushed forward. The posterior part of the tumor is smooth, rises abruptly from the choroid, and is covered by the pigment layer. The anterior part is nodular and uncovered. The retina is detached. Under the microscope a uniform accumulation of

large pigmented and unpigmented round and irregular cells is seen, distinguished by large round and oval nuclei, with very conspicuous shining nucleoli. The intercellular substance is scant and finely granular. *Anatomical Diagnosis: Round-celled melano-sarcoma of the choroid.*

No. 10. Glioma.—A German girl, $3\frac{1}{2}$ years of age, was brought to me in October, 1872, with intense pain and swelling in the left eye, accompanied by great pallor and exhaustion.

The lids and conjunctiva were so greatly œdematous, in addition to a slight exophthalmos, that a diagnosis by simple inspection was impossible. I must confess I was wholly unable to determine the true anatomical relation of the tissues. On the administration of ether, the edges of the lids and the position of the cornea could be brought to view, when the folds of œdematous conjunctiva were pressed to one side.

The simple statement of the brother, that a peculiar glistening appearance deep in the eye first attracted the notice of the parents, six months before I saw the child, removed almost every doubt that might exist, whether the disease was suppurative choroiditis or glioma. I at once urged the extirpation of the globe, simply to relieve pain. It was remarkable how rapidly the child recovered, for a time, its blooming appearance. Death occurred at the end of six months.

The eyeball is filled by a white, soft substance, in which the crystalline lens and shreds of the choroid are recognizable. The white, soft tissue protrudes from the interior, through a large opening in the sclerotic, forming an external tumor about the size of a hazelnut. The lens-fibres are preserved, and here and there moderately interspersed with small, round cells. The tumor consisted of small, round cells, closely set in a granular matrix.

Anatomical Diagnosis: Glioma.

No. 11. Glioma.—R. S., $4\frac{1}{2}$ years of age, was brought to me Aug. 4th, 1876, with her right eye much enlarged, but not especially tense. The cornea was enormously distended, and presented a peculiar, pinkish appearance.

The father stated that in March, 1874, the child had an attack of obscure disease of the brain, after which she could not see with the eye.

Soon after, the pupil was observed to be dilated. In April, 1876, the globe began to enlarge. The father could not describe satisfactorily the early changes in the pupil and cornea. The patient experienced much suffering, to relieve which extirpation was advised. In the following December I learned that the orbit was filled with the cancerous growth.

The globe, a little above the size of that of an adult, is completely filled with a homogeneous, soft substance. The sclerotic is thinned. Of the inner tissues, shreds of the uveal tract only, and the crsytalline lens, which is pressed against the cornea, are recognizable. The optic nerve was not in the half of the globe delivered to me. The whole tumor had a uniform structure of small, round cells, imbedded in a scant, granular matrix.

Anatomical Diagnosis: Glioma.

No. 12. Melanotic Sarcoma of the Cornea and Sclerotic.—Mrs. H., 40 years of age, observed for many years a small dark spot at the upper and inner quarter of the corneal border of the left eye. Two years previous to the extirpation of the globe, by myself, in October, 1873, this growth began to assume the form, though not the usual color of a pterygium. This her family physician removed twice. It grew more rapidly after each operation, although it scarcely impaired the vision.

The centre of the specimen rests upon the sclero-corneal juncture, with which it is intimately connected; the lateral parts overlap the sclerotic and cornea, without being united to them. The growth, therefore, is pedunculated. Its bulk consists of white and colored round cells and nuclei, with shining nucleoli. A delicate, fibrous stroma pervades the growth, and in some places gives it an alveolar appearance. Numerous larger and smaller blood-vessels, with very thin walls, pervade the pseudoplasm. At the periphery, especially in the episcleral portion, the fibres are coarser and more numerous, and the cellular infiltration consists of small, round elements. Only the outer layers of the corneo-scleral juncture are invaded by the elements of the growth.

Anatomical Diagnosis: Pedunculated melano-sarcoma of the corneo-scleral juncture.

No. 13. Epithelial Cancer of Cornea and Sclerotic.—Mr. H. C. H., 40 years of age, states that two years and a quarter previous to the removal of the globe, he first observed a minute, painless elevation, at the margin of the inner portion of the left cornea, which grew very rapidly. During the last eighteen months it had been removed twice, and burned with caustics several times by his family physician. At the date of extirpation, Jan. 20th, 1875, the tumor was round, one-third of an inch in diameter, with abrupt edges one-eighth of an inch high, the surface being yellowish red, rough and villous, not unlike certain warts often found on the hand. Vision was almost normal, as the pupil was scarcely covered with the growth.

The conjunctiva posterior to the tumor was greatly thickened. This portion was removed with the globe.

The tumor was intimately connected with the sclero-corneal juncture and the cornea, but only overlapped the adjacent sclerotic. It consisted exclusively of epithelial cells, which, without any peculiar—for example, papillary—arrangement, lay one near the other. Only the outer layers of the sclerotic were invaded by the epithelial elements, whereas the greater part of the cornea was either destroyed or infiltrated by the epithelial cells. The corneo-scleral juncture probably was the original seat of the pseudoplasm.

Anatomical Diagnosis: Epithelioma simplex limbi conjunctivæ et corneæ.

No. 14. Tumor of Optic Nerve.—Miss M. L. M., æt. 10½ years, first observed a slight exophthalmos of the right eye in September, 1874. At the end of a year the patient accidentally discovered that this eye was totally blind. The last week in April, 1875, the patient, in every respect a remarkably fine-looking, healthy child, came under my care.

The right eye protruded between the lids to such an extent that the latter scarcely moved in winking, and could not be closed with the strongest effort. The axis of the globe was directed forward, possibly in the slighest degree outward. The globe was quite movable in every direction.

The orbit seemed filled with a very hard tissue, which did not develop anteriorly in one portion more than in another.

The cornea and other refracting media were perfectly clear. The pupil was moderately dilated. There was total obscuration of the contour of the optic disc, the central portion being, however, grayish, the arteries small, the veins large. The lids and ocular conjunctiva were somewhat œdematous.

The patient had recently experienced pain above the eye and dizziness, especially in bending forward.

An exploratory incision at the external angle, with a division of the rectus, enabled the tip of the finger to discover a tumor of the optic nerve, scarcely quarter of an inch behind the sclerotic. After considerable manipulation, I discovered that I was unable to remove the tumor without sacrificing the globe. The tumor was finally separated from the adjoining tissues with difficulty, and removed from the orbit. So absolutely close to the optic foramen was the growth, and so free from any appearance of normal optic-nerve tissue was its posterior portion, that I was certain the optic nerve within the foramen was also diseased. The tumor, surrounded by quite a firm capsule, was remarkably succulent and soft, especially at its posterior portion.

The convalescence was somewhat longer than is usual after extirpation of the globe. During the night, and next morning after the operation, the patient vomited blood several times. A small quantity of blood flowed from both nostrils for some hours. At the end of the second day the lids became greatly swollen, and at the close of the fourth day it was evident, from the pain and tension, that suppuration had taken place. These symptoms began rapidly to disappear the next morning, upon the free discharge of pus from between the lids. After this the recovery was very rapid.

One of the first symptoms of which the patient complained, after the effects of the ether had subsided, was a total loss of feeling over a portion of the right half of the forehead and scalp, embracing about four square inches. The brow and lid retained perfect sensitiveness. At the end of a week the affected portion regained its normal condition. I may add that in three cases I have observed temporary but painful numbness of the left shoulder and arm, immediately following the recovery from the ordinary effects of ether.

The tumor so completely filled the orbit that there was difficulty in enucleating it. This was accomplished by the gradual introduction of

a blunt instrument between the tumor and the adjoining bones. I cannot believe that the bleeding from the nostrils was caused by any injury to the internal wall of the orbit.

At the end of two years, I learned from the parents that there have been no indications of a return of the tumor.

The specimen, hardened in alcohol, was oblong, measuring 30 mm. in its antero-posterior, 23 mm. in its horizontal, and 17 mm. in its vertical diameter. At its anterior end was a piece of optic nerve 10 mm. in length, the transverse section of which, macroscopically, showed nothing abnormal, either in the nerve or in its external sheath, but the subvaginal space was considerably enlarged, and filled with a loose, soft, fibrous tissue. This enlargement of the subvaginal space was somewhat more marked in the vicinity of the eye than in the vicinity of the tumor.

The whole tumor was surrounded by a fibrous capsule, which represented itself as the direct expansion of the outer sheath of the optic nerve. A longitudinal section of the tumor, through and in the direction of the optic nerve, discovered the following: On one side, in the immediate vicinity of the sheath, appeared a fibrous cord 2 to 3 mm. thick, passing almost unchanged from one end of the tumor to the other. It was a portion of the optic nerve.

At the entrance of the nerve into the tumor, the fibrous portion was broader, and expanded, fanlike, into the new growth. The centre of the tumor was uniformly softish, and irregularly fibrous, the periphery somewhat denser, fibrous, with parallel striation. Its connection with the sheath was loose, over the preserved part of the nerve, but more or less firm over the remainder of the growth. Over the nerve the sheath had its natural thickness, but was very much thinned upon the convexity of the tumor.

The bulk of the tumor consisted of an irregular network of long, delicate fibres. The places of intersection were enlarged, and contained small cellular elements. The interstices of the fibres were transparent and homogeneous. In other places the fibres were more or less parallel, and inclosed the same cellular elements. Near the entrance of the optic nerve into the

tumor, the nervous fibres were seen to pervade the substance of the growth in bundles, which by division and subdivision became smaller and smaller, and at last were lost in the reticulated structure of the growth. At the inner side of the tumor the nervous fibres passed along the sheath of the nerve in the shape of a more or less compact cord. The border of this cord, which touched the growth, was ill defined, the nervous fibres intermingled with and lost themselves in the network of the growth. The specimen belongs to the most frequent variety of optic nerve tumor, namely the *myxo-fibroma*.

No. 15. Panophthalmitis, with a Clot simulating a Tumor.—Mr. ——, a mulatto, æt. 29 years, submitted to the extirpation of the right globe, April 19th, 1876.

In Dec., 1874, he had been under my care for simple phlyctænular eruption on the corneal border, which readily subsided after the use of atropine and calomel, locally applied. In Dec., 1875, the patient again appeared with precisely the same condition of the eye, stating that the organ had been perfectly well during the year. The same remedies as before were applied, but without benefit. On the contrary, the iris became seriously inflamed, and also the cornea, with active suppuration, and the formation of anterior choroid of staphyloma. The patient suffered much pain. As he fully comprehended the condition of the eye as regards vision, but was very desirous of retaining as good a stump as possible for an artificial eye, I removed simply the cornea, iris, and staphylomatous portion of the sclerotic in the middle of Jan., 1876.

The patient, as the wound did not heal kindly, preferred to be under the care of his family physician, but at the end of three months again came to me for advice, stating that he had been confined nearly the whole period to his room, and much of the time to his bed, on account of pain and great prostration.

The globe was peculiarly hard, but not staphylomatous; it was considerably smaller than normal. At the time of the second attack of phlyctænular trouble, it did not occur to me to test the vision, nor to make an ophthalmoscopic examination. A section of the enucleated globe revealed the following condition:

The globe is about two-thirds the normal size. The choroid is thickened, its stroma densely filled with pus corpuscles, through

which the pigmented stellate cells are irregularly scattered. In the axis of the eye lies the wrinkled and disorganized retina, enclosing a grumous substance, composed of pus corpuscles and fusiform cells, with very long offsets (suppuration of the vitreous). On one side of the specimen, occupying about a quarter of its space, is situated a roundish, white, softish, somewhat fibrous tumor, surrounded by thickened choroid on all sides, and pressed against the sclerotic. Under the microscope it consisted almost exclusively of an irregular network of white fibres. At its periphery there was a considerable accumulation of white, and of some red blood-corpuscles. I had never before seen such a compact clot, resembling a tumor in so many respects, yet the examination proves that it is only *coagulated fibrine*. In spite of the scarcity of red blood-corpuscles in the mass, I think that most probably it resulted from a *hemorrhage*.

CONTRIBUTIONS TO THE PATHOLOGICAL ANATOMY OF THE HUMAN EYE.*

By Dr. ADOLF ALT, M.C.P.S.C., of Toronto, Can.

(With Plates II., III., and IV.)

I.

A Case of Intraocular Telcangiectatic Alveolar Sarcoma, with Formation of True Cartilage.

The formation of true cartilage in the human eye has been described only once by H. Knapp.† When that tumor was examined, it seemed to be a pure enchondroma; later, however, it appeared most probable that the cartilage was formed in sarcomatous tissue, and had, while growing gradually, destroyed the latter. The conditions of the tumor now under discussion also seem to speak for this opinion.

The eyeball was removed from a Mexican boy, in Vera Cruz, April 30th, 1875, by Dr. E. Hegewisch, six months after the first appearance of the tumor, and kindly given to me for microscopical examination.

The history is briefly the following: Antonio M——, eight years of age, was struck on his right eye about eight months previous to the operation. About two months after this injury a small growth, which was connected with the tissue of the sclerotic, appeared at the inner angle. This tumor grew very rapidly, caused excruciating pain, and bled very freely and spontaneously, when touched but slightly.

The tumor (Pl. II. fig. 1.), when hardened in Müller's fluid, measured about 4 centimeters in each diameter. It was divided by a meridional section. From the macroscopic conditions it

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* Under this heading a series of interesting pathological specimens will be described.

† Vol. III., 1. pp. 1–16 of these Archives.

appeared that the growth had originated at the region of the ciliary body, and had grown forward from that point. The cornea had been perforated, and the new formation surrounds the external surface of the globe almost to its equator. Large cavernous spaces, especially at the periphery, give it a sponge-like appearance. Partially imbedded in the intraocular, partially in the extraocular portion of the tumor are some small islets of a totally different, dull, shining, elastic tissue.

The entire retina is detached and torn from the entrance of the optic nerve; the posterior part of the choroid is not in contact with the corresponding part of the sclerotic. The retina is folded and pressed by a gelatinous exudation, and agglutinated to the tumor in the region of the ora serrata. Its folds contain some remains of the vitreous body. The posterior part of the sclerotic is of normal thickness; where surrounded by the tumor, it is gradually thinned. The remains of the cornea are lost in the tumor. The optic papilla has been excavated, but this excavation has, later on, filled with a fine connective tissue. Just around the optic-nerve entrance the choroid is atrophic and firmly attached to the sclerotic (Pl. II. fig. 2).

Microscopic Examination: The elements composing the tumor are mainly round cells of the shape and size of the white blood-corpuscles or somewhat larger. Among them lie a few spindle-cells. At the region of the ciliary body, and near the choroid, some of the cells are pigmented. A very fine intercellular substance unites the cells with each other. Hence, we have to deal with a white, round-cell sarcoma. The tissue of the tumor is divided into alveoli of various sizes by broad or thin bands of connective tissue. The alveolar structure is most pronounced near the sclerotic and about the remains of the cornea, and it is easily seen that the bands of connective tissue originate from the tissues of the latter. Numerous blood-vessels of all sizes pervade the new formation. In its periphery they form large and small cavernous spaces, which give the tumor the character of a teleangiectatic growth.

The islets of a different tissue, which have been mentioned above, consist of a hyaline matrix, in which are imbedded

numerous cartilage-cells. Every one of these islets is surrounded by a capsule of dense connective tissue, fibres of which pass into the substance of the sarcoma. Here we have to deal with true hyaline cartilage (Pl. II. fig. 3). As the cartilage-cells show the picture of partition and augmentation of the nuclei, the tissue must be either growing or decaying; since, in one of the islets, the centre is formed of fœtal cartilage (Pl. II. fig. 3) passing over into permanent cartilage at the periphery, I believe it to be growing. The hyaline matrix of this central part is very scarce in proportion to the number of cells (Pl. II. fig. 5), of which latter several are inclosed in one capsule, and of which the greater part have more than one nucleus. It thus appears to me that the cartilage is growing from the centre towards the periphery, which opinion contradicts the observations of H. Knapp. I can, however, not find any picture in my tumor which might produce the idea that the tissue of the sclerotic had been transformed into cartilage, and, on the other hand, it is an entirely natural process that the formative cells of the sarcoma develop into cartilage-cells.

Where surrounded by the tumor, both the remains of the cornea and the sclerotic are split into fibres, which undergo frequent anastomoses. This network of connective-tissue bands extends through the whole tumor, and produces its alveolar structure. The process by which the formation of these alveoli is caused, is doubtless the following (Pl. II. fig. 6). In the first stage, small clusters of sarcomatous cells are imbedded in the tissue of the sclerotic or cornea. By the increase in number of these cells, the surrounding tissue is distended gradually. In this way alveoli of the first order are formed. If, then, new clusters of cells enter the walls of the primary alveoli, they give rise to secondary, tertiary, etc., alveoli. The intercellular substance of the tumor, apparently, does not participate in the formation of the alveoli.

The choroid, so far as it has been taken up by the tumor, has undergone similar changes. The invasion of cells here especially concerns the vorticous veins; the chorio-capillary layer nearly everywhere is normal. The growing cell-clusters distend

the walls of the veins, and the pigmented cells become atrophied and pale, and the remains of free pigment are scattered about.

The retina is changed into connective tissue, and only few vestiges of its nervous elements are to be found. Müller's supporting fibres have grown very broad, and they inclose occasional large empty spaces (œdema?). Some granular round cells occupy the region of the outer granular layer. The external limiting membrane is everywhere well preserved.

The numerous folds of the retina surround a myxomatous tissue, which is the degenerated vitreous body. This is proven by some unchanged cells of the vitreous. The opinion lately advocated, especially by Schwalbe,* that the cells of the vitreous body are nothing but white blood-corpuscles, makes the transformation of the latter into connective tissue still more probable. So does the development of pseudo-membranes in this organ.

The excavated entrance of the optic nerve is very much encroached upon by the sclerotic. A newly formed fine connective tissue fills the excavation, and abounds with free particles of pigment. The optic nerve is very much atrophied.

This being a case of choroidal sarcoma in a boy eight years of age, makes it of some interest, which latter is increased by the formation of cartilage. The history and the anatomical examination do not admit a doubt of its nature as a sarcoma. Sarcomatous tumors in other organs are not infrequently chondro-sarcomata. Formation of cartilage, however, has, as far as I know, never been described in gliomatous nor any other intraocular tumors (except Knapp's case).

Some tissue which a year ago has been removed from the orbit was no relapse, but simply hypertrophied conjunctiva. The other eye is free from any disease.

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* Graefe and Saemisch, VI. 1.

II.

On the Changes produced in an Eye by the Lodgment of a Foreign Body for Twelve Years within it.

For the globe, which is to be described in the following, I am indebted to Dr. H. Knapp.

The history of the case shows that the patient had first been seen by Dr. Knapp, while in Heidelberg, November 27th, 1864. The following was recorded in the house-book of his ophthalmic hospital, on that day. K. Hagenbüchle was struck in the right eye by a piece of steel, one year ago. *Status Præsens:* A black point (the entrance of the foreign body) is found, one line outward from the corneo-scleral margin. The piece of metal lies at the region of the ciliary processes, downward. Arteries small, veins broad, papilla hyperæmic. Reads Jaeger No. VIII., L. normal.

Diagnosis: Traumatic Retinitis.

Although this is the only written record of the case, Dr. Knapp has seen the patient several times since, both in Europe and here. Except the inflammatory reaction produced by the injury, and a gradual diminution of sight in that eye, no remarkable changes took place during the period of twelve years.

December 4th, 1875, the patient came to the N. Y. Ophthalmic and Aural Institute, stating that for two days only his right eye was inflamed. The left eye had been weak for some time. There was very painful purulent irido-choroiditis in the right, lachrymation and photophobia in the left eye. Patient did not know the cause of the recent inflammation. The right eye at once was enucleated by Dr. Knapp. All symptoms in the left disappeared.

When the globe was hardened, and cut in the equatorial region, the following macroscopic conditions were found (Pl. II. figs. 7 and 8).

The entire sclerotic is very thin. Choroid and retina are firmly attached to it. The vitreous body is liquefied, and contains some floating, purulent matter. The foreign body lies

upon the not folded part of the ciliary body. It is a piece of blackened metal, about 5 mm. in length (Pl. II. fig. 7, *f*). This foreign body is imbedded in tough connective tissue, into which strong bands are inserted, which come from the ciliary part of the retina, the hyaloid and the ciliary processes. Its free edge looks toward the vitreous body. A tough membrane, folded, and dull shining, lies at the place of the lens, and covers a part of the pupil. The optic papilla is very small. At the region of the macula lutea, and not far from it, a small piece of retina is detached by some exudation. The anterior halves of the choroid and retina are firmly attached to each other, and together have not even the thickness of that part of a normal retina alone.

Microscopic Examination: The purulent matter floating in the vitreous body consists of pus-cells, of large and small drops of fat and of fibrine. There are also some large hyaline bodies, with a folded cell-membrane, but without a nucleus, and some others of the shape of amylon-bodies, which are fully transparent, and have no nucleus either.

The same are found in specimens taken from other parts of the vitreous body (Pl. III. fig. 9). There is only a small number of normal vitreous cells. Most of them look as if filled with small and large globules. They have no nucleus. Whilst these globules are light and like empty spaces, the remainder of the cell is granular, and has a yellowish tint. Some cells are made up altogether of those globules. It is most probable that these cells are in some connection with the amylon-like bodies, as to their origin, but this cannot be proven. Numerous little membranes are floating in the vitreous (Pl. III. fig. 10). They are nothing else but lens-fibres, which are dimmed by fat molecules. Their nuclei are well preserved.

Since the aqueous humor contains the same transformed cells and lens-fibres, there must have been a communication between the aqueous and vitreous humors and the lens, and between each other.

What has been called above a tough membrane, covering a part of the pupil, is the collapsed capsule of the lens. It

incloses some dim lens-fibres, Morgagni's fluid, and transformed cells of the vitreous body. There are, besides, very large cells, containing a dim granular matter. These cells have been described by O. Becker* as being formed after discission of the lens, and have been called "giant-cells." Neither in the "giant-cells" of this, nor of any other cataract have I been able to detect a nucleus. There are large and small hollow spaces in them, which sometimes appear like a nucleus.

It is remarkable that the remains of the lens do not show any pus-cells whatever, in spite of their communication with the aqueous and vitreous humors, where pus was found. Also the nuclei of the fibres did not proliferate.

Some small heaps of pigment-granules, arranged in the form of a circle upon the anterior capsule, are the remains of posterior synechiæ.

The tough tissue, in which the foreign body is imbedded, is formed by the sclerotic, choroid, ciliary body, ciliary part of the retina, retina and vitreous body, in the following manner. The foreign body has pierced half the thickness of the sclerotic and severed its fibres, which now contain hæmatoidin-crystals, the remains of a hemorrhage. The fibres of the sclera have partially grown around the foreign body. The remaining part of this ring of tissue is formed by a dense, pigmented connective tissue, the constituents of which cannot be discerned. It may, however, easily be seen that the different membranes, where they approach the foreign body, as above mentioned, are transformed into connective tissue, and pass over into the ring surrounding it.

The pigment filling all of these membranes is derived from the pigmented epithelium, the pigmented cells of the parenchyma of the choroid, and from hemorrhages.

The different parts of the choroid are not any more characterized as such, the whole membrane having undergone connective-tissue degeneration. Only a few vessels are found. The thickness of the membrane is very much reduced by this

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* Graefe and Saemisch V., 1, p. 175.

process. Anteriorly, to the equator, choroid and retina cannot be severed. Plain views taken from this part show a dense, fibrated connective tissue, with much granular pigment. The remaining vessels are compressed from both sides, and appear, therefore, perfectly flattened. They contain an abnormally large amount of white blood-corpuscles. Some of these latter are very large, and have two or three nuclei. The pigmented cells of the parenchyma of the choroid are destroyed. The few remaining cells of the supra-choroidal layer are very pale.

Only a small number of cells of the pigmented epithelium are preserved. They are irregular in shape, and pale. Some have several, some have no nuclei.

Near the entrance of the optic nerve and the macula lutea the retina is normal, except, perhaps, that the layer of nervous fibres is somewhat thinner. At various places the limitans interna is detached by small heaps of round bodies, whose nature I do not know. Towards the ora serrata the nervous elements gradually disappear, and Müller's supporting fibres are thickened; anteriorly to the equator, the structure of the retina is entirely destroyed, and this membrane is transformed into dense connective tissue, and agglutinated to the choroid. The new-formed connective tissue, by its retraction, has reduced the thickness of these membranes to such a degree as to render it less than the normal thickness of the outer granular layer at the equator.

The optic nerve is atrophied. The lamina cribrosa is thickened, and incloses only very few nervous fibres.

The ciliary body and iris are likewise atrophied. They have but few vessels. Their parenchyma contains an abnormal number of white blood-corpuscles.

III.

A Case of Dislocation of the Lens under the Conjunctiva.

The remark of O. Becker's,* stating that there is no anatomical description of a case of dislocation of the lens under the

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* Graefe and Saemisch, V., 1, p. 302.

conjunctiva on record, has induced me to describe the following case:

The eye, the conditions of which shall here be spoken of, was among a number of eyes given to Dr. Knapp by Dr. Mooren, of Düsseldorf. No history was added to these eyes. The one under consideration bore the clinical diagnosis of amaurosis after choroiditis ectatica. Recent cyclitis, and the remark, "enucleated for sympathetic ophthalmia."

The shape of the bulb seemed to justify this diagnosis. It was nearly cuboid, and a bulging body, covered by conjunctiva, lay near the lower corneal margin. A meridional section carried through this bulging part revealed the following macroscopic conditions (Pl. II. fig. 11):

The cornea is curved much stronger than normal—its posterior surface is wavy. The bulging body consists of a tough tissue, inclosing the lens, which is recognized by its concentric layers. A broad string of scar-tissue lies between cornea and sclerotic, at the corneo-scleral margin. In it are imbedded some remnants of the iris and pigment. A new-formed membrane is stretched across the eyeball to the opposite ciliary body, and there incloses the latter and the iris. This ciliary body has been detached by the retraction of the cyclitic membrane.

At the region of the corneo-scleral scar, the ciliary body cannot be recognized. The choroid is seen as a thin black streak, which a little farther backward is detached by an exudation from the sclerotic. The condition of the choroid on the other side is the same.

The retina is detached in funnel-shape, and with its anterior parts firmly attached to the cyclitic membrane.

All the cavities of the eye are filled with a bloody gelatinous exudation.

Microscopic Examination.—Around the corneo-scleral wound, the epithelial layers of the cornea and conjunctiva are very much thickened. The corneal lamellæ and Descemet's membrane are wavy. The fixed cornea cells can be readily discerned by the slight staining, owing to Müller's fluid. This is most pronounced in the lips of the wound; there the cells are

swollen, and have sometimes two nuclei. There are also a number of round cells in the corneal tissue and many new-formed blood-vessels.

The margins of the cornea and sclerotic are severed by new-formed connective tissue, in which are lying some remains of the iris, pigment in cells, and a large number of round cells. These parts are covered by condensed conjunctiva. Beginning from the scar-tissue, a cyclitic membrane crosses the eye, as above described. The pigment and vessels of the iris and ciliary body have grown into this membrane. The sclerotic here is abnormally vascular and contains some round cells.

There are some few muscular fibres contained in the scar-tissue, the only remains of the ciliary body of that side. The wound-lip of the sclerotic is infiltrated with round cells. The choroid, where it is firmly attached to the sclerotic, is atrophied; where it is detached, it is much thickened, which is due to an immense amount of round cells, hyperæmia of the vessels, and proliferation of the pigmented epithelium. The round cells are at some places more crowded, as if forming small abscesses.

The entire retina, even its ciliary portion, is detached and drawn towards the axis of the globe. The tissue is degenerated into connective tissue, and only the region of the outer granular layer, which seems the most resistant, can be differentiated. There are some round cells scattered about between the fibres of the connective tissue.

Where the conjunctiva covers the dislocated lens, this membrane is very tough, strongly vascularized and pigmented. The lens-capsule is firmly attached to it, folded and thicker than normal. Only the inner and two-thirds of the outer side of the lens (in meridional sections) are inclosed in lens-capsule. This was apparently torn in the direction of a meridian near the equator. The epithelium of the lens-capsule is replaced by a dense tissue, made of spindle and a few large round cells. Some delicate lines running through this tissue are probably new-formed vessels. The adjacent part of the lens is decaying and filled with Morgagni's fluid and Becker's "giant-cells."

The equatorial diameter of the lens is smaller, the meridional larger than normal.

The conditions of the scar-tissue show that the injury had been received in the least from three to four weeks before the enucleation, most probably, however, much longer.

Anatomical Diagnosis: Injury to the cornea, sclerotic, iris and ciliary body; dislocation of the lens under the conjunctiva, rupture of the lens-capsule; incarceration of the iris and ciliary body by new-formed connective tissue; detachment of the ciliary body and choroid; purulent and hemorrhagic panophthalmitis.

The error in the clinical diagnosis is perfectly excused by the conditions of the globe. The cataractous lens, covered with the condensed conjunctiva, may very easily have been mistaken for a partial staphyloma. The conditions of the fundus oculi, of course, could not be seen.

IV.

On the Colloid Excrescences of the Lamina Vitrea Choroideæ as a Starting Point for the Formation of Bone.

Ever since eyes with ossification have been examined by the different authors, it has been a matter of course to find out in which preformed parts of the eye the formation of bone first took place. So far it has been said that the connective tissue alone was this preformed tissue. This is certainly so, where the formation of bone is found in a cyclitic membrane. There are some extensive papers on record of the ossification of the choroid alone, especially by A. Pagenstecher, H. Knapp, and Schiess-Gemuseus.

In the following I propose to state some anatomical facts, which explain a hitherto unnoticed mode of formation of bone in the human eye.

Already H. Müller found crystals of chalk in the colloid excrescences of the lamina vitrea of the choroid, so well described by himself, Donders, Wedl, and others. Prof. Nagel*

* Zehender, Klin. Mtsbl. XIII., Sept., 1875.

lately has seen the same with the ophthalmoscope. It is to be regretted, however, that the microscope was not able to support his ophthalmoscopic and chemical diagnosis. Prof. Nagel has the opinion that Müller's fluid dissolves chalk. Against this opinion I may simply state that the eyes, the conditions of which are now under discussion, had been in Müller's fluid for years. Besides these, I have a considerable number of specimens showing chalky deposits in nearly all parts of the human eye, in which Müller's fluid did not dissolve the chalky concrements, but made them much more conspicuous by a greenish-yellow tint, which I am accustomed to look upon as characteristic for chalk.

The colloid excrescences do not seem to be very frequent. Among nearly one hundred and fifty eyes I examined, and for which I am indebted to Prof. H. Knapp and a number of other oculists, I found this condition only seven times. The excrescences had the same appearance stated by all former authors on this subject.

In three eyes, however, I found, besides the common excrescences, such containing chalky deposits, and a smaller number being transformed into bone. Others had retained the shape, but consisted entirely of bone-tissue.

The following are the microscopic conditions.

The lamina vitrea of the choroid almost always can be traced only just to the margin of the excrescences. In other specimens, the excrescences seem to be merely deposits, since the wavy lamina vitrea lies unchanged under them. This might, however, be explained by the assumption that my sections were cut obliquely. The common excrescences consist of a more or less transparent, sometimes a little granulated substance, and show a sharp outline, when the pigmented epithelium is totally wanting. But this is very rare. Pigment molecules cover the inner surface of the excrescences almost always, whilst they are surrounded at the bottom by normal pigmented epithelium, which shows a darker pigmentation. Only very small excrescences are entirely covered by the normal pigmented epithelium. These common

excrescences show the well-known resistance against chemical agents.

Where we find chalky deposits in the excrescences, they have commonly the shell-like shape (Pl. III. fig. 12) of the phosphate of lime, as we see it in other tissues. These deposits may be dissolved by acids and then a hyaline (colloid?) matrix remains. They hardly ever fill the entire excrescence. In a number of such bodies we find that a small part of the chalky material has become more transparent and homogeneous, and assumed the green color which bone has always after having been in Müller's fluid. This seems to be the beginning of the ossification. In a small number of these homogeneous nuclei, there are bone corpuscles (see *os.* Pl. III. fig. 13). In other excrescences, this nucleus of bone-tissue is larger and the surrounding phosphate of lime smaller. Finally the shape of the colloid excrescence is yet preserved, but it consists entirely of bone. These little plates of bone then coalesce and form larger ones.

The conditions here described were the same in three eyes. There are in all of them larger plates of bone around the optic-nerve entrance, and the changes in the colloid excrescences are most pronounced near these plates.

The remaining tissue of the choroid is atrophic in one, normal in the second, and hypertrophied in the third, a phthisical eyeball.

It is therefore proven that not only chalk may be deposed in the colloid excrescences, but that they can become organized and changed into bone-tissue.

I cannot state how often this process takes place, nor whether the colloid excrescences became ossified before or after the other parts of the choroid. In early stages of ossification we always find the bone in the innermost part of the choroid resp. the chorio-capillary layer. This statement, made by A. Pagenstecher and H. Knapp, is fully supported by what I have found in examining fourteen eyes with ossification of the choroid.*

* Dr. Kipp, of Newark, told me lately that he, too, has found ossification of the colloid excrescences in two eyes. Here I may relate also that I found the same colloid excrescences *upon the limitans interna of the retina.*

In plane views they are apparently the same roundish hyaline bodies, coalescing with each other as those upon the lamina vitrea of the choroid. Since the internal limiting membrane can be detached with them, it is certain that they really lie upon it. The transverse sections show the same picture as those of the colloid excrescences of the choroid; some are entirely homogeneous and hyaline, others a little granular. They, on the whole, do not reach the size of the choroidal excrescences, but are just as resistant against chemical agents.

This retina was not detached from the choroid, but degenerated into connective tissue and contained much pigment. I do not know, however, whether there existed a typical pigmentary retinitis. The eye in which I found this condition is from Dr. Knapp's collection. The colloid excrescences covered only a small equatorial part of the retina, and I never found them in any other eye.

V.

On Cysts in the Cornea.

Cysts I found in the parenchyma of the cornea of four eyes. For one of these I am indebted to Prof. Laqueur; the remaining three are from Dr. Knapp's collection. The history of three of these eyes stated that the cornea had been perforated; in the fourth, the microscope shows this same condition. The following, however, will prove that what I call cysts are not "cystoid scars," but the results of a particular process concerning only a small portion of the parenchyma.

In all of the cases, the cysts are everywhere surrounded by corneal tissue. Two of the cysts are lined with uveal pigment and filled with serous fluid. Of the remaining two, one has perfectly smooth walls without a coating of pigment, the other shows a number of fine trabeculæ passing from one wall to the other and forming various anastomoses.

The direction of the largest diameter of these cysts is parallel to the lamellæ of the cornea. They thus appear flat. The

thickness of the cornea is but very little altered, where the cysts are found.

The mode of development of the pigmented cysts is apparently the following. Some particles of the uvea remained in the corneal wound after the perforation had occurred, which then, by their proliferation, destroyed the surrounding corneal tissue. This process seems the most probable in one of the eyes, which, besides the cyst, shows total anterior synechia and corneal staphyloma. The condition of this eye does not allow to assume that I have to deal with a mere incarceration of iris, and that the cavity in the cornea was open towards the anterior chamber, at a place wherefrom I happened not to make a section.

The unpigmented cysts do not allow of any such mistake at all. There are two ways possible of the development of these cysts. One is, that they have been formed in the wound-plug (Wundpropf). We then must assume that one part of this was in any way disorganized and has not been absorbed, while the remaining part was converted into connective tissue. If this be so, the cavities in a later stage most probably would have been filled or healed by attachment of their walls.

The other way is indicated by the cyst which has the network trabeculæ. This gives entirely the same microscopic picture which we find macroscopically in abscesses of long duration. It seems, therefore, the most probable that this cyst is the result of a corneal abscess.

VI.

On an Isolated Gummous Tumor of the Ciliary Body.

A gummous tumor I found in an eye which was in Dr. Knapp's collection, with the clinical diagnosis of specific iridocyclitis, and had been enucleated in Charity Hospital.

This ciliary body appeared macroscopically very much thickened. The microscopic examination revealed the following.

Especially the anterior half of this single ciliary body is much thickened by an accumulation of round cells. These round cells show all the peculiarities of white blood-corpuscles. They

are more crowded in the centre of the tumor and are there decaying into fatty detritus. There are no vessels in the new-formation.

The muscular fibres apparently take no active part in the formation of the growth. They are crowded aside by the round cells. In specimens taken from the centre, only a small number of atrophic fibres lies anteriorly to the tumor (Pl. III. fig. 15); most of them are crowded backward. In specimens taken from the periphery, the number of muscular fibres is increased by those of the centre, which were pushed aside. The greater number of the muscular fibres is normal; they inclose some round cells. There are but few vessels in the tissue which surrounds the tumor.

The uveal pigment is destroyed, especially upon the height of the tumor, and its cells, as well as much free pigment, are scattered among the round cells. Anteriorly and posteriorly to the tumor the uveal pigment is proliferating.

A tough cyclitic membrane surrounds the ciliary body. It consists of the proliferated retinal part of the ciliary body, the detached retina which is degenerated into connective tissue, and some new-formed connective tissue. This membrane lies behind the normal lens and contains much pigment, new-formed vessels, and extravasations.

There is, besides, purulent iritis and choroiditis and a hemorrhagic purulent exudation in the vitreous body.

The anatomical condition, united with the clinical diagnosis, do not allow any doubt as to the gummous nature of the tumor. It, however, is only one symptom of a general specific purulent panophthalmitis.

In the literature at my disposal, I cannot find the description of such an isolated gummous tumor of the ciliary body. Dr. Fr. Delafield,* describing two cases, speaks of a diffuse gummous new-formation in the ciliary body which, besides, involved other parts of the eye; in the case of Drs. Loring and Eno,† also the episcleral tissue showed a tumor.

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* Transactions of the Amer. Ophth. Society, 1871. † Ibid., 1874, p. 174.

VII.

To the Histology of the Pterygium.

Only a very small part of the literature on pterygium is at my disposal, especially do I lack of the paper, by Schreiter, who commonly is thought an authority on that subject. What Sæmisch* states in his paragraph on pterygium shows plainly that the clinicists only judged from the clinical development, while the anatomists only examined pterygia which were detached from the eye by the operation on the living. It, therefore, may be of some interest to know the conditions I found in an eye with pterygium which came into my possession twelve hours after the death of the individual. The other eye, which showed the same pathological condition, was refused to me.

The axis of the pterygium lies a little above the insertion of the internal rectus muscle, and its basis is in the conjunctival *cul-de-sac*. Its form is, like always, that of a wedge, and it ends upon the cornea just above the small iris-circle with a sharp, roundish margin. It can be lifted from both sides, and is adherent to the underlying tissue in a line which lies somewhat below its axis.

Sections through the apex of the pterygium and parallel to its axis show the following conditions.

The pterygium enters the cornea as a different tissue in form of a wedge, and lies just about where the outer third of the thickness of the cornea begins (Pl. IV. fig. 16). This different tissue is dim and somewhat granular, and consists of fine fibrillæ, a part looking like detritus, and a few round and spindle cells. The nearer the corneal margin, the thicker it is, and there it assumes the structure of conjunctival tissue.

This interposed tissue alters only the outer lamellæ of the cornea. They are pushed outward, so as to make them strike the normal lamellæ at any acute angle. The so changed lamellæ are very granular and dim. The number of cells between

* Græfe and Sæmisch, IV., 1.

them is very small in the part corresponding to the corneal margin. The lamellæ which lie just above and around the apex of the pterygium, however, are filled with an abnormal number of cells and are granulated also.

Bowman's layer has been bent towards the apex of the pterygium, so as to leave the larger part of the pterygium uncovered (Pl. IV. fig. 16).

The corneal epithelium passes over into that of the pterygium. The latter shows a basal layer of cylindrical and an outer layer of flattened cells, as we find it in the bulbar part of the conjunctiva.

In sections made at a right angle to the axis of the pterygium, and taken from the region of the corneo-scleral margin, I find several layers of epithelial cells separating the underlying tissue from that of the pterygium (Pl. IV. fig. 17). These cells are partially horny, partially undergoing colloid metamorphosis. Some of the latter appear as round vesicle-like cells, filled with colloid, and have a large round nucleus. In others the colloid infiltration affects as yet only the nucleus, and the cell-body is normal. Some have a well-marked nucleolus. These cells surround some large and small hollow spaces, in one of which some detritus is lying.

The surface of the pterygium is not smooth, as Schreiter describes it, but very wavy (Pl. IV. fig. 16) and folded. The epithelium which covers it is uniformly thick, and never sends offsets into the underlying tissue.

The tissue of the pterygium is merely the tissue of the conjunctiva, which appears somewhat condensed, especially at the apex of the former. It consists mainly of fibrillæ which run more or less parallel and contain but few cellular elements. The mucus-like tissue, which, according to Schreiter, forms the peripheral parts, is entirely wanting in this specimen. Conjunctival vessels of different sizes are very numerous in the tissue of the pterygium, and form a capillary network near its apex. The vessels are all congested. The epithelium is the conjunctival epithelium.

The results of this examination agree with the opinion of

those who explain the development of pterygium by the attachment of a fold of conjunctival tissue to a *marginal ulcer* of the cornea.

The procedure may be the following. A fold of the conjunctiva, which latter is perhaps in a state of blennorrhoic inflammation, and the epithelium of which is no longer normal, overlaps a marginal ulcer of the cornea, and thus becomes attached to it. In this way its epithelium would be incarcerated between conjunctiva and cornea, as in the case above. The tissue now covering the loss of substance of the cornea is inflamed and proliferating. The proliferation can take place easily in the direction of the degenerated lamellæ of the cornea. During this proliferation the epithelial cells which cover the conjunctiva where it is applied to the borders of the ulcer are destroyed, and only those which cover its outer surface remain and unite with the epithelium of the cornea. This foreign tissue now constantly irritates the surrounding corneal tissue, and thus the walls of the ulcer are constantly loosened, and give the pterygium a new opportunity to grow.*

EXPLANATIONS OF PLATES II., III. AND IV.

Fig. 1. Shows the entire tumor described in No. 1. *E*, are the islets of cartilage tissue, as they were struck by the meridional section.

Fig. 2. Entrance of the optic nerve of the same eye.

Fig. 3. Two islets of cartilage tissue in their capsules. The centre of one is formed by fœtal cartilage.

Fig. 4. From the stationary cartilage. Augmentation of nuclei.

Fig. 5. From the fœtal cartilage.

Fig. 6. Shows how the tissue of the sclerotic forms the alveoli of the tumor.

Fig. 7. Anterior half of the globe described in No. II. *F*, Foreign body.

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* See my Clinical Report on 3,873 Eye Patients, etc. This same number of the ARCHIVES.

Fig. 8. Posterior half of the same, macula lutea and circumscribed detachments of retina.

Fig. 9. Peculiar bodies from the vitreous.

Fig. 10. Some lens-fibres floating in the vitreous; cells containing vacuolæ attached to them.

Fig. 11. Subconjunctival dislocation of the lens (*L*).

Fig. 12. Colloid excrescences of the lamina vitrea choroideæ containing phosphate of lime.

Fig. 13. The same showing beginning ossification (*Os*). *R*, detached retina; *Sc*, sclerotic; *Ch*, choroid; *Dr*, colloid excrescences.

Fig. 14. Cyst of the cornea lined with pigment-cells (*Cy*).

Fig. 15. Gummous (*G*) tumor of the ciliary body. *I*, iris; *L*, lens; *CM*, cyclitic membrane.

Fig. 16. Section through the apex of the pterygium and parallel to its axis. *ACL*, detached lamellæ of the cornea; *NCL*, normal lamellæ; *B Sch*, Bowman's layer, bent; *Pt*, tissue of the pterygium.

Fig. 17. Section near the corneo-scleral margin and at a right angle to the axis of the pterygium. *EgE*, incarcerated epithelial cells, which are partially horny, partially ndergoing colloid metamorphosis. *CSF*, tissue of the corneo-scleral margin.

(*To be continued.*)

OPHTHALMOLOGICAL REVIEW.

By H. KNAPP and E. GRUENING.

1. Boll, Franz. Zur Anatomie und Physiologie der Retina (Contributions to the Anatomy and Physiology of the Retina). Abstract in *Zehender Klin. Monatsbl. f. Augenheilkunde*, xv., Feb., 1877, p. 80.

2. Kuhne, W. Zur Photochemie der Netzhaut (Contribution to the Photo-Chemistry of the Retina). Abstract in *Zehender Klin. Monatsbl.*, Feb., 1877, p. 81.

3. Stammeshaus, W., Dr. Darstellung der Dioptrik des normalen menschlichen Auges. Oberhausen and Leipzig, 1877. (Treatise on the Dioptrics of the normal human eye.)

4. Faber, C., Dr. Der Bau der Iris des Menschen und der Wirbelthiere (The Structure of the Iris of man and the vertebrates). Prize Essay. Leipzig, 1876.

5. Conrad, Max. The Refraction of 3,036 eyes of School Children, with regard to the Transition of Hypermetropia into Myopia. Leipzig, H. Kessler, 1876.

6. Rosenstein, H. Untersuchungen über die örtliche Einwirkung der sog. Adstringentia auf die Gefässe. (*Wurzburg*, *phys.-med. Verhdlg.* 1876, ix., S. 32.) (Investigations on the local effect of the so-called astringents upon the blood-vessels.)

7. Laqueur, Prof. Ueber eine neue therapeutische Verwendung des Physostigmin (On a new therapeutical application of physostigmine). *Centrlbl. f. med. Wissensch.* No. 24, 1876.

8. Wecker, L. de. Glaucom and Augendrainage (Glaucoma and ocular drainage.) Graefe's *Arch. f. Aghlkde.*, xxii., p. 209.

9. Arlt, Prof. Dr. Blepharoraphia medialis. *Wiener Med. Wochenschrift*, No. 40, Sept. 30th, 1876.

1. Boll has made the important discovery that a retina, examined in the freshest possible state, does not appear colorless, but presents a red color which, upon being exposed to ordinary daylight, disappears very rapidly. The significance of this discovery lies in the fact that it confirms the correctness of Hering's theory of color. Hering has specu-

latively anticipated Boll's discovery, by maintaining that the action of light upon the perceptive retinal layer was productive of chemical changes which might serve to explain the perception of color.

2. In direct sequence of Boll's discovery, Kühne instituted a number of experiments in order to study the influence which the various kinds of light possess, of causing the disappearance of the red color of the retina. He found that good daylight produced the change in half a minute, strong gaslight in 20 to 30 minutes, sodium light in 24 to 48 hours, a cover of red glass in 6 hours, of green in 4 to 5 hours, and of blue in 2 hours.

3. This elementary treatise on the dioptrics of the eye contains in its first part a description of the refraction of light by a system of centered spherical surfaces. The method, though somewhat circumstantial and tedious, especially when compared with the treatment of the subject by analytical geometry, possesses, nevertheless, the great didactic advantage of being easily understood and mastered by any one familiar with trigonometry and algebra. The whole is preceded by an introductory chapter intended as a guide to the study of the laws of lenses, and the optical qualities of the eye.

The second part treats of the eye as an optical instrument. The measurements of the schematic eye are based on the optical constants recently adopted by Helmholtz (1874), which differ from the former essentially in the diminished refractive power of the lens, and the increased curvature of the cornea.

4. F. demonstrates a complete endothelial coat on the anterior surface of the iris, a continuous musculus dilatator pupillæ, Bruch's basement membrane, a stratified layer of pigment on the posterior surface of the iris, and an endothelial coat covering the pigment-cells.

5. *Conrad* made his examinations in children from 8 to 18 years of age and more. He determined ametropia both with Snellen's test types and the ophthalmoscopes (Loring's first). He found that the OS almost constantly revealed a lower degree of refraction, about $\frac{1}{30}$ at an average, than the reading test. He states that according to his investigation 70% of the children of six years of age are hypermetropic, and thinks that in younger children the percentage is still greater. On examination with Sn's test types he finds that H is met with in 16% at the age of eight years, and falls to 6.7% at the age of 18 years, M rises from 11.1% to 62%. On examination with the OS he finds 70% of H at the age of eight years, which gradually sink to 23% at the age of 18 years, whereas

M rises from 4.3% to 5.17%. The percentage of E thus determined remains almost equal, 25%, during that time. He explains this as follows: Emmetropes, seeing distinctly and without an effort at short distances, make no increased prolonged accommodative efforts. Hyperopes, by accommodating forcibly and long, produce congestion and those changes in the interior of the globe which render the eye myopic. Thus hyperopia, which in childhood is the normal condition, is by school life converted into myopia. The reasoning would be correct, if his ophthalmoscopic determinations really revealed the true refractive condition, and the visual act, as he supposes, almost always were effected under a certain strain of accommodation.—His tables show that the lower degrees of M during school life gradually are converted into higher degrees. Low degrees of M form, however, the great majority of the myopes in all classes. S was 1 (perfect) in 83.20%, $= \frac{2}{3}$ in 7%, and $< \frac{2}{3}$ in 9.72% of all myopic eyes. Higher degrees of M showed a greater percentage of defective S than lower degrees.

Among the 3,036 eyes staphyloma posticum was found in 245. Its frequency in the different refractive conditions showed the following relation: of the eyes affected with staphyloma posticum, 77.96% were myopic, 12.65% emmetropic, and 9.39% hyperopic.

In regard to *treatment*, respectively prevention and arrest of M, he recommends to render reading, etc., easy, both by making S as sharp as possible, and by preventing forced accommodation, which generally may be effected by weak concave prismatic glasses.

6. R. examined the effects of solutions of argentum nitricum, plumbum aceticum, acidum tannicum, gallicum and pyrogallicum, ferrum sesquichloratum and alum, by applying them to the mesentery of curarized frogs, and measuring the calibre of the affected vessels with the micrometer. The most powerful contraction was produced by nitrate of silver in a solution of 1 to 10%, the observations being often disturbed by the ensuing partial opacity of the tissues. The contraction in many cases involved one-half of the lumen, both of the arteries and veins, being less marked in the capillaries, and manifesting itself in the course of a few seconds. R. observed a stoppage of circulation in the affected vessels, which was permanent in the capillaries, but at times only transitory in the arteries and veins. Tannic acid, contrary to expectation, was found to have the opposite effect, dilating arteries, veins and capillaries as much as one-half of their calibre, while they became at the same time choked with blood-corpuscles. The dilated vessels imme-

diately contracted on the application of nitrate of silver. Gallic and pyrogallic acid were found to have the same effect as tannic acid. Acetate of lead produced a contraction of the arteries and veins, though less markedly than nitrate of silver. Its effect could not be traced to the capillaries. Occasionally, a stoppage of the circulation was observed. The vessels almost invariably contained white coagula, consisting of conglomerated, colorless blood-corpuscles, often adhering to the walls of the vessels, and thus giving to their transverse sections a beaded appearance. A 10% solution of liquor ferri sesquichlorati had no perceptible effect. A 50% solution caused a contraction of the vessels, though in a still lower degree than acetate of lead. This contraction was limited to the arteries and veins, while the capillaries remained dilated. A frequent result was coagulation and discoloration of the blood within the vessels. A discrepancy was observed in the results of the various experiments with alum solution. The vessels were, in some cases, contracted, in others dilated; while in others again no appreciable change was noticed. In the capillaries, especially the smaller ones, the circulation often ceased.

In order to prevent reflex action, R. extirpated the spinal column of the frog, and destroyed the communication between the vessels and the heart, without changing in any way the local effect of the substances above mentioned. From the results of these experiments the author infers that only nitrate of silver and acetate of lead can be said to exert an astringent action, *i. e.*, to cause contraction of the tissues, this effect being of uncertain occurrence in alum and the liq. ferri sesquichlor. and entirely absent in the tannic acid group.

7. The observation that atropine instilled into the eye of a person predisposed to glaucoma, may bring on an acute attack of this disease, has led L. to inquire whether physostigmine would act antagonistically to atropine in regard to effect upon intraocular pressure. He employed Duquesnel's eserine (sold at the Pharmacie Vée, 42 Faubourg St. Denis, Paris) in an aqueous solution of $\frac{1}{3}$—$\frac{1}{2}$%, of which he introduced 3—4 drops into the conjunctival sac, at intervals of 20 minutes. The drug was continued three weeks in this manner without causing any unfavorable symptom. L. experimented on five cases of primary and one case of secondary glaucoma (following partial dislocation of the lens), and observed that the instillation of eserine invariably reduced the pathological increase of intraocular pressure, and that the reduction became more and more marked up to the 8th or 10th day.

8. Græfe's theory of the inflammatory origin of glaucoma has been universally abandoned, and Donders' view of the neuropathic character of the disorder almost as universally accepted. According to Donders, the increase of ocular tension peculiar to glaucoma should be regarded as the result of heightened functional activity of the secretory nerves. Wecker is of opinion that even under physiological conditions of secretion an increase of the intraocular pressure may ensue, whenever the excretion of the secreted fluids is retarded.

An increase of tension is brought about by the abnormal accumulation of fluids and the augmentation of the ocular contents. In order to explain the origin of glaucoma, it is therefore unnecessary to resort to the assumption of a problematic neurosis, as we find a more plausible explanation in the fact, that the ocular membranes have undergone definite pathological changes.

In support of this view Wecker adduces the following facts :

1) The occurrence of pathological changes in the sclerotic. (Coccius, Cusco.)

2) The development of glaucoma at a period of life when senile changes occur in the ocular membranes, affecting their elasticity and, perhaps, their permeability.

3) The frequency of glaucoma in eyes that show a marked thickening of the hyaline membranes and proliferation of their epithelial layers, conditions which materially influence the excretion of the ocular fluids.

4) The manifest heredity of glaucoma, its predominance in certain races (Jews), the rarity of its occurrence in certain districts (Algiers); circumstances which argue greatly in favor of a hereditary disposition as regards the permeability of the ocular membranes.

5) The cessation of the glaucomatous phenomena after iridectomy, sclerotomy and so-called myotomy can be explained in a natural manner by the formation of a filtration scar. The disturbed equilibrium is re-established and the glaucoma cured by filtration through the scar.

Considering that filtration plays a very important part in the operation of glaucoma, W. tried to find a means which would cause filtration to take place in case the scar should prove insufficient for that purpose, and as the result of his experiments recommends drainage as the best mode of drawing off the ocular fluids both in normal and abnormal conditions of secretion. The drain is effected along a thin and flexible gold wire passed through the eye in the form of a loop.

From his experiments, W. infers that the drainage loop diminishes the ocular tension in a far higher degree, and terminates the glaucomatous attack much more rapidly than iridectomy. He does not, however, intend to substitute drainage for iridectomy, but thinks that it may prove of great value in the following conditions, in which the performance of iridectomy is very difficult, fraught with danger, and, moreover, insufficient:

1) *Absolute Glaucoma*, with atrophy of the iris, abolition of the anterior chamber, hardness of the globe and excessive painfulness.

2) *Hemorrhagic Glaucoma*, where the sudden diminution of ocular tension, caused by the incision, occasions rupture of the intraocular vessels.

3) The continuance of increased tension after a broad iridectomy.

9. Under the title of "Blepharoraphia Medialis," Arlt publishes an account of a procedure, the object of which is to cause a narrowing of the palpebral fissure at the inner canthus, in the same manner in which, by the operation of tarsoraphy, a similar result is obtained at the outer canthus. The operation of blepharoraphia medialis is indicated in cases of facial paralysis, an affection in which the lower lid, especially the inner half, is no longer in contact with the globe, and stands at the same time considerably below its normal position. These conditions subject the eyeball to a variety of affections, which culminate in suppurative keratitis and loss of the eye.

The reapplication of the median half of the lower lid and its reduction to the normal position are brought about in the following way: Below the lower lachrymal point, a fold of cutis 2–3 mm. in width is taken up with a fixation forceps, the branches of which are directed upward and downward. By means of delicate straight scissors a cut is made in the direction of the inner canthus, and a strip of cutis removed 6–7 mm. in length. The upper boundary of the wound is formed by the palpebral conjunctiva and the caruncle. Mutatis mutandis, the upper lid is treated in the same manner. The two ribbon-shaped wounds meet at the outer edge of the internal canthal ligament like the sides of a V. When the slight bleeding has ceased, the wounds are united by three sutures, passed through the cutis.

OTOLOGICAL PART.

A FOREIGN BODY IN THE EXTERNAL AUDITORY CANAL CAUSING REFLEX NERVOUS SYMPTOMS —REFLEX HEMICRANIA.

Dr. L. Heydenreich, St. Petersburg.

Translated by Clarence J. Blake, M.D., Boston.

As an appendix to the recent address of Prof. Moos * on "the connection between epileptiform symptoms and aural disease," the following case may be considered, generally speaking, as a contribution to the etiology of this condition.

It is especially worthy of note, however, in that it does not come under any one of the three divisions made by Moos of reflex symptoms accompanying aural disease; namely, reflex epilepsy, reflex hemiplegia, or reflex psychosis, but must rather be considered as reflex hemicrania.

The foreign body, which had remained in the left external auditory canal for a period of nine years, was a swollen sunflower seed.

The mother of the girl Barbara Golubewa, twelve years of age (from Beresitschi, district of Kaluga), reported that the seed had been put into the child's ear by children with whom she was playing, when three years of age. The seed had been pushed so far into the ear that neither the mother nor the attending physician could extract it, and the latter declared that the parts implicated were too delicate to permit of its removal; the mother (an uneducated peasantess) therefore abandoned all hopes of relief and sought no further professional counsel.

The first year passed without special symptoms, except that from time to time the child felt acute lancinating pain in the

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* These Archives, vol. iv., pp. 102–107.

ear; there had not been a purulent discharge at any time. The lancinating pains in the left ear continued unabated during nine years, and were especially severe and unbearable during the occurrence of headache. This headache began during the second year after the introduction of the foreign body. The pain occurred periodically and was at first slight, but steadily increased in severity. The attacks occurred usually about once a month, lasting from two or three to seven days. During these attacks the patient felt dull pulsating pain in the opposite (the right) side of the face, which she described by the words, "as if some one struck her with a hammer." The pain extended to the left side of the face, but was here decidedly less severe.

During the continuance of the pain, there were also decided sensations of alternate heat and cold. Both the body and face were at first hot and then so cold that she shivered.

The pain was at times so severe that she lay motionless for hours, and would allow no one to touch her. Consciousness was never lost. During the attacks the appetite failed, but there were no disturbances of digestion and no vomiting.

Aside from these attacks, the child was usually well, and experienced no disturbance beyond the lancinating pains above mentioned.

When brought to me for relief from the severe pain in the head, it was only by minute questioning that I was directed to the presence of the foreign body in the left ear.

The patient presented the following appearance. The skin generally pale and delicate, the body somewhat poorly nourished and thin, the lips and face somewhat shrunken, flax-colored hair, the articulations of the extremities enlarged, the abdomen enlarged, the cervical lymphatics enlarged and plainly perceptible as small hard lumps, the tonsils also swollen; organs of the chest and abdomen normal.

On the right side the patient heard the ticking of a watch at a distance of 0.783 metre; on the left side, 0.387 metre. In the left external canal was a dark-brown hard body, entirely filling the passage, with exception of a small slit above. It was deeply

situated, so that each touch with a probe caused pain (probably from its contact with the membrana tympani). This foreign body was removed with little difficulty, but not without causing considerable pain. Under illumination by means of a Türk's laryngoscopic mirror, the superior posterior portion of the auricle being drawn upward, the blades of a common forceps were introduced above and below the foreign body, closed as firmly as possible, and then quickly withdrawn, effecting the extraction successfully at last, although the forceps slipped several times.

The foreign body, a sunflower seed, had been pushed into the ear with the broad end inward ; it was larger than usual, covered by its brown shell and a layer of cerumen, and of its usual hardness. An examination of the ear showed a smooth dilatation of the canal corresponding to the size of the foreign body. On the membrana tympani and the walls of the dilatation there was no observable abnormality beyond a few reddened spots. Immediately after the operation, the patient felt a decided relief, but during the next five visits the hearing distance remained unaltered. At present, one year and two months later, the ticking of the watch is heard on the right side at a distance of 1.609 metre, on the left side at a distance of 1.394 metre. The hemicrania above described has not once recurred since the operation.

In another case, in which a tarack (*Blatta Germanica*) was removed from the left ear of a peasant thirty-three years of age, where it had remained for months, aside from unimportant local disturbance, there were no reflex symptoms.

As above remarked, the case first cited may be denominated reflex hemicrania, evidently resulting from the irritation of trigeminus branches in the external canal, caused by the presence of the foreign body. It is, however, remarkable that the opposite side was implicated and that the attacks occurred at long intervals.

OTOLOGICAL REVIEW.

By Clarence J. Blake, M.D., of Boston.

I. J. Hughlings-Jackson. On Nervous Symptoms with Ear-disease. *British Med. Journal*, March 24th, 1877.

II. The same. Observations on Ménière's Disease.

III. W. R. Gowers. The Diagnosis and Treatment of Auditory-nerve Vertigo. Reprint from *British Med. Journal*, 1877.

IV. J. Breuer. Beiträge zur Lehre vom statischen Sinn.

V. Israel. Ueber nervöse Erscheinungen, veranlasst durch einen Fremdkörper in der Paukenhöhle. *Berl. Klin. Wochenschr.*, 1876, No. 15.

VI. Adam Politzer. Ueber einen einheitlichen Hörmesser. *Archiv für Ohrenheilkunde*, xii. Bd. 2. H.

VII. Lancassagne. Des unions consanguines, de leur influence et des rapports de la consanguinité avec la surdi-mutité congénitale. *Ann. des mal. de l'oreille*, 1876, p. 265–298.

I. This is a synoptic view of the various symptoms which accompany disease of the walls of the tympanic cavity (and often of the bone), with discharge of some duration from the ear.

1. Neuralgic pain, probably only symptomatic of exacerbation of tympanic disease.

2. Bell's paralysis. In no uncomplicated case had he ever seen paralysis of the same side of the palate. If he should meet with it, he would diagnosticate *intracranial* disease, even if aural disease were present; but uncomplicated facial paralysis with aural disease is not a cerebral symptom, hardly an ear symptom, but rather a bone symptom. Bell's paralysis is not often, nor essentially, a precursor of fatal cranial mischief. It does not necessarily show great extension of the cerebral mischief. Complete recovery often follows.

3. Tubercle of the brain or cerebellum—in the absence of general tuberculosis—in the place, so to speak, of abscess from ear disease; it presents the symptoms of cerebral abscess.

4. Cerebral or cerebellar abscess, and meningitis. The diagnosis is difficult between these two. Hemiplegia and convulsions are not apt to be *early* symptoms in abscess; rather, severe headache or vomiting,

and optic neuritis. Delirium is very poor evidence of the existence of acute primary disease of the brain of any kind. The abscess acts, not by compression, but by causing local encephalitis; sudden and unexpected death may occur; the intense pain which is felt in the latter sort of cases must be met by opiates, as it may of itself destroy life.

5. Pyæmia, which may be mistaken for No. 4. Excessive pain is absent, and general febrile symptoms, with delirium, are common.

6. Hemiplegia of opposite side in children. The author has seen no autopsies; the causation is very obscure, but he suggests venous thrombosis, leading to local softening.

7. Epilepsy. The author does not accept the hypothesis of reflected irritation, but suggests the possibility that aural disease may lead to disease in Hitzig's and Ferrier's regions; or that venous thrombosis may cause local softening.

8. Ménière's disease. Almost any kind of ear-disease would cause paroxysms of vertigo and reeling, with faintness and vomiting. There are five great varieties of vertigo, viz.: 1. stomachic, 2. nervous (often sexual) exhaustion, 3. ocular, 4. epileptic, 5. aural or auditory.

II. The author mentions the existence, in certain cases, of an *inter-paroxysmal* condition, reeling, to which the patient is always liable. It is like the walk of a man slightly drunk, and exactly like that of patients who walk badly from disease of the cerebellum.

Probably the part of the auditory nerve which goes to the cerebellum does not come from the cochlea, but from the semicircular canals, and is therefore intended for the regulation of the *leading* movements of locomotion, those of the head and upper part of the trunk (Goltz). The author thinks that the semicircular canals regulate certain movements *in relation to one another*, while the eyes regulate the movements of the body *as a whole* in relation to some outward object. While the cochlear division enables us to *hear* music, he believes the canalicular division regulates the rhythm of movement; and the two functions are combined in dancing.

The vertigo from lesion of the auditory apparatus is paralleled by that which occurs in paralysis of the third or sixth nerve; in the latter case vertigo is not due to diplopia. These nerves preside over locomotor movements of the eyes—those which are symbolic of the locomotor movements which estimate distance. There are associations of ocular movements of convergence and divergence (the former especially downwards, the latter especially upwards), with those movements of the

spine, legs, and arms in locomotion, represented in the cerebellum, for ideas of distance.

The deep pallor, clammy perspiration, sense of faintness, and vomiting, of Ménière's disease, may doubtless be explained by the relations of the deep origin of the auditory to the nucleus of the vagus.

Dr. Jackson speculates on the character of the two orders of movements associated with hearing, viz.: those of the bust and those of the heart. As the notion of extension is not gained without movements of the eyeball, so, in his opinion, does the notion of the succession of time depend on the unconscious observation of the rhythm of the heart.

III. It seems that a morbid state of the semicircular canals may predispose to vertigo, as well as excite it. A permanent defect in the functions of the semicircular canals, being slight, or compensated or allowed for in the sensori-motor adjustments, without causing vertigo, may yet probably induce a state of defective stability in the centre for equilibrium (cerebellum), in which it is easily excited to sudden perverted action (paroxysmal vertigo) by some abnormal impression on the other nerves with which it is connected, as the gastric or pulmonary branches of the pneumogastric.

In diagnosticating from gastric vertigo (strictly so called), the most significant change is the loss of the power of hearing a watch in contact with the skull. Tinnitus is also to be attended to.

As to the character of the vertigo, the sensation which results from a primary gastric disturbance is usually vague, a confused sense of defective equilibrium; that which results from a labyrinthine affection is definite, a sense of motion in a certain direction, subjective or referred to other objects, in most cases.

In making the diagnosis from epilepsy, the definite character of the vertigo is no criterion. A more important symptom is its persistence between the paroxysms and its long duration in the paroxysms themselves. If it can be produced by certain sudden movements of the head, or is succeeded by vomiting, or if consciousness (in mild attacks) is not lost, the inference is against epilepsy.

In regard to treatment, marked relief may be given by blistering behind the ear, if there is evidence of an irritative process, or by colchicum and potash if the change is gouty. Syphilis may be a cause. Salicylate of soda, given in doses of five or ten grains, three times a day, has seemed to lessen the giddiness in two cases of the author's.

Strict and unintermitted regimen may relieve gastric cases, and an actual attack may often be arrested by a good dose of an antacid. Bromide of potassium or ammonium probably does more good than any other single remedy, but no one is to be relied on solely.

IV. Breuer has published in the form of "Beiträge" a continuation of a former article upon the theory of the vestibular apparatus, based upon experiments with the centrifugal machine, and upon vivisections of the semicircular canals. He considers that the vertigo produced by these two classes of experiments is identical. The efforts which an animal makes to recover its equilibrium may be guided by the muscular sense, the sense of touch, or the sight, which guide the body as a whole, or by the ampullary nerves, which take cognizance of the smallest movements. The horizontal canals of the two sides correspond with each other; also the right frontal with the left sagittal, and the left frontal with the right sagittal. This correspondence is established by cutting across both members of a pair, when the animal loses entirely power of orientation in the corresponding plane. In some of his experiments the author departed from the usual method; opening the canals without injury to the nerves, he blew in upon them, in order to imitate the supposed effect of rotation in increasing the hydrostatic pressure; he found the result to correspond with the previous theory, inasmuch as the animal turned its head in the way to be expected. When the opposite procedure was employed, namely, diminishing the pressure by suction, the result of his experiments was less decided, but when successful, it was confirmatory. He supposes that the auditory hairs are easily moved from their position of equilibrium by an impulse in the endolymph, and that a cessation of the impulse, owing to the inertia of the fluid, will set the hairs in motion in the opposite direction. Another theory of his supposes the ampullary nerves to be in a state of constant slight excitement under the gentle continuous flow of endolymph. This hypothetical self-stimulation he compares with the independent perception of light in the retina, and states that its effects are held in equipoise by the fact that the organs on both sides of the head are stimulated at once.

V. The possible ill effects of allowing a solid body to remain within the tympanic cavity are illustrated in the case of a young man of 20, who tried to clean his ear with a lead pencil, and left the ivory head in the meatus. The attempts to extract it pushed it quite deeply into the tympanic cavity. A month after the accident, he had a rigor with a

temperature of 41.1°, falling in twenty-four hours to the normal point. The pain disappeared. Dating from the chill, on the 16th day the temp. was 39.6, and the fever lasted eleven days, until the body was removed by an operation. There were tearing pains in both arms. 17th day, shooting pains in both arms, the entire trunk and hips, while the head and ear were free from subjective trouble. The hearing was impaired, discharge from ear absent, left pupil dilated, slight fibrillary twitching in the muscles closing the left eye and the elevators of the left ala nasi. Very great hyperalgesia of the painful regions of body ; when a fold of skin was raised the patient cried out loudly. Light pressure on the nerve-trunks belonging to the left brachial plexus was very painful both in the fossa supraclavicularis and the arm. 18th day, repeated bilious vomiting, pulse irregular, but not retarded, intelligence clear. Suddenly a contracture of the fingers of the left hand occurred, pressing them so firmly into the palm that it was difficult and painful to straighten them. The contracture, hyperalgesia, pain, inequality of pupils, disappeared in half an hour after the injection of $\frac{1}{3}$ milligramme of atropia, but the hyperalgesia returned, and with it came pain in all the teeth. On the 21st day the foreign body was extracted through an incision behind the auricle, and the hyperalgesia ceased entirely in three days. Israel explains the symptoms as of reflex origin, arising from the pressure of retained pus.

VI. Prof. Politzer's instrument is intended to supply that great desideratum, an accurate test of hearing according to an absolute standard. His attempts in this direction have resulted in the construction of instruments of identical materials, size, shape and weight; but the sounds produced, as in the case of tuning forks of identical construction, are so far different that tuning of the resonant cylinder by filing is required. The instrument may be described as follows: A round stick of hard rubber, of the bigness of a lead pencil, and a convenient length, has at each end a semicircular attachment with the concavity directed outwards, to place the forefinger and thumb in. To this stick is screwed firmly, at right angles, a solid steel cylinder, 29 millim. long and $4\frac{1}{2}$ mm. in diameter. Through a slit in the rubber passes the handle of a little steel hammer, pivoted at the slit. The end of this handle has but a limited play ; when depressed by the finger, the head is raised ; when let go, the head falls upon the steel cylinder. The sound produced is like the sound of a loud-ticking watch, and is tuned to c ; it is nearly free from over-tones, and is not affected

by the degree of pressure with which the instrument is grasped. It is extremely simple, and costs in Vienna only $5\frac{1}{2}$ gulden. The inventor promises soon to publish an average normal hearing distance for the instrument.

VII. The transmission of traits from parent to offspring is intensified by the circumstance that both parents possess the same or similar traits. Such a similarity may be assumed as probable when the parents are blood-relations. Usually there is no difficulty in the development of the organs of vegetable life; the trouble begins with the formation of the pigment-tissues, the hair, skin, etc., and increases with the nervous organs, in which we find disturbances of nutrition and of development, defective development in the brain and organs of sense, etc.

The great frequency of deaf-mutism among the offspring of blood-relations was pointed out by Ménière in 1856. Rilliet, Barthez and Bevay followed. Boudin believed that the number of deaf-mutes was greatest in those countries where there are fewest obstacles to marriages between blood-relations; he stated also that the affection is common in children of ordinary marriages, when one of the parents is the offspring of such a close marriage. But deaf-mutes who marry, unless they themselves spring from a consanguineous marriage, very seldom produce deaf-mute children.

Mitchell has published statistics of 45 consanguineous marriages, which exhibit a large number of cases of various mental and nervous disorders and tuberculosis, and two of deaf-mutism. He remarks that it would be easy to find a parallel among 45 families where the parents are not related. Yet he concludes that the fact of relationship is prejudicial in proportion to its nearness. Burton states that one case in ten of deaf-mutism occurs in the offspring of consanguineous marriages. On the other hand, in a number of small insular or remotely situated communities, it has been found that very frequent blood-intermarriages are consistent with an extremely vigorous health among the entire community, and an almost total absence of deaf-mutism. Bourgeois and Seguin have published family trees, going back two centuries, containing a great many intermarriages among relatives, but without examples of deaf-mutism, hydrocephalus, etc. Bally in France, and Child in England publish similar facts. The Chinese forbid these marriages, but have a considerable proportion of deaf-mutism (Martin). The author therefore considers that the marriage of blood-relations is not by itself a dangerous thing; that if both parties are strong and healthy,

the results will be positively good; but that they are decidedly dangerous in the class of people who live exposed to the deteriorating influences of modern life in large cities.

I am indebted to Dr. D. F. Lincoln, of Boston, for the service kindly rendered in the preparation of the above Review.

CLARENCE J. BLAKE.

ARCHIVES

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AND

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IN CONJUNCTION WITH

DR. E. GRUENING, OF NEW YORK, AND DR. CL. J. BLAKE, OF BOSTON.

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A.—OPHTHALMOLOGICAL PART.

OPHTHALMOLOGICAL PART.

CONTRIBUTIONS TO THE PATHOLOGICAL ANATOMY OF THE EYE.

By Dr. AD. ALT,

Of Toronto, Canada (late of New York, N. Y.).

(With Figs. 13–16, on Plate VII.)

VIII.

Description of an Eye enucleated for Sympathetic Neuro-retinitis of its Fellow. Studies on the Development and Nature of the Corneo-scleral Staphyloma without preceding Injury.

I. In a paper on sympathetic neuro-retinitis, read before the International Congress of Ophthalmology, in New York, Sept., 1876, I promised a more detailed description of an eye enucleated after having caused this affection in the other eye. (V. Report of the Fifth Intern. Congr., p. 43, Case VII.) I then stated the macroscopical changes as: corneo-scleral staphyloma; total ectasia of the globe; central and disseminate atrophic chorio-retinitis; detachment of the vitreous body; exceedingly deep glaucomatous excavation; atrophy of the optic nerve.*

Retina and choroid are at different places firmly attached to each other, especially in the periphery and the regions of the macula lutea and optic-nerve entrance. In other places, the membranes may be separated easily, but the pigmented epithelium adheres much more to the retina than to the choroid.

The conditions in these latter parts are the following:

1. In plane-views of the choroid, the pigmentation of the

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* N.B. I may say here that the patient W. H. has since that time retained a vision of $\frac{20}{30}$. The hemorrhage in the macula is entirely absorbed. The papilla, however, has a rather whitish appearance. (March, '77.)

parenchyma seems somewhat irregular, which changes, however, I would not call pathological. Differences in pigmentation are found in every choroid, and are more conspicuous in a negro's eye. The vessels are well preserved, partially filled, partially empty. Where the pigmented epithelium adheres to the choroid, it shows the following particulars. The pigment-granules, apparently larger than common, lie at the margin of the cells, thus leaving the entire nucleus free. The cells are roundish and vary in size. In parts where they show the arrangement which is seen in disseminate choroiditis, a number of pigment epithelial cells is apparently destroyed. These free pigment-granules are scattered about. Others are much larger than normal and have two and three nuclei. The cells which surround these parts of destruction are very dark, so that neither their nuclei nor the margins of each cell can be distinguished. It thus appears as if the living cells had taken up the greater part of the pigment of the destroyed ones.

2. In surface views of the retina, the most marked changes are seen in the outer layers. The pigmented epithelium shows the same forms as in the choroid. There are branched streaks of pigment in the outer layers, arranged like blood-vessels. No evidence, however, is found that they are in any connection with the blood-vessels of the retina, which never lie in the outer layers. If this picture could have been seen during life, it would certainly have led to the diagnosis of pigmentary retinitis. Three of the larger blood-vessels of the retina are also partially pigmented. The pigment, however, does not lie in the proper walls of the vessels, as commonly described, but in the lymph-sheath. This pigment has certainly been transported by the current of the lymph-fluid.

All parts of the retina are more or less atrophic. Müller's fibres form a large network of broad bands of connective tissue, in the meshes of which the remains of the cellular elements are found. The walls of nearly all the blood-vessels are three and four times as thick as normal. Their lymph-sheath is frequently obliterated by new-formed connective tissue, the result of a real perivasculitis.

The nearer the ora serrata, the more pronounced is the atrophy. The most peripheric parts of the retina form a very thin membrane perforated by numerous round and oval holes of different sizes. This atrophic part consists of connective tissue and round cells. The blood-vessels are nearly all obliterated by the new-formed connective tissue. Besides the holes in this tissue, there are seen numerous vacuolæ. If the origin of the large holes may be found in the cavities characteristic for this region of the normal retina (Iwanoff: œdema retinæ), this explanation will hardly hold good for the smaller vacuolæ. There is no trace of contents in them. Sometimes they seem to have a membrana propria. In some parts I found large cells, like vesicles, with a round, central nucleus; perhaps they bear some relation to the vacuolæ.

3. Transverse sections show that the parenchyma of the choroid in these parts is entirely normal, and that the disease only involves the pigmented epithelium.

Transverse sections of the retina prove the atrophy and connective-tissue degeneration. They show very well how the pigmented epithelium has proliferated into the outer layers of the retina, where it forms the ramified streaks. In some places where the connective-tissue degeneration is very far advanced, the pigment reaches nearly the limitans interna. The transverse sections also confirm the above-stated condition that, where pigment is found attached to the blood-vessels, it does not lie in their walls, but in the lymphatic space surrounding them.

The above remarks concern only the parts of retina and choroid which can be easily separated. The conditions are very different where these membranes are firmly grown together.

A small zone of choroidal parenchyma around the places of attachment is infiltrated with round cells. They lie equally numerous in all its layers, but are not numerous enough to destroy its entire structure. This zone of infiltration unites directly a part of the choroid, which has been transformed into dense, tough connective tissue, which has no blood-vessels and shows only small remains of the choroidal pigment. In the

centre of this atrophic patch the lamina vitrea is broken, and the pigmented epithelium proliferates irregularly into the connective tissue of the choroid. Just in this central part the retina is firmly adherent to the choroid, while in the surrounding parts it is a little detached. The retina is atrophic in a high degree, and where it is detached, the rods and cones are changed into club-shaped bodies.

In some of these patches, there is a direct union of the tissue of both membranes. It is impossible to say if the choroid, which is changed into connective tissue, has grown into the similarly transformed retina, or vice versa. I can simply say that in these places both the lamina vitrea and the pigmented epithelium are traversed by a broad band of dense connective tissue, which consists of spindle-cells and very few round cells. (See Fig. 13, Plate VII.)

Lens, zonula Zinnii, and ciliary nerves are normal.

The entrance of the optic nerve shows an excavation, which even in the hardened eye is yet 3 mm. deep. The optic nerve is changed into connective tissue pervaded by a large number of blood-vessels.

The parts of the cornea which are not involved in the corneo-scleral staphyloma are thinned; its centre more than the adjacent parts. The parenchyma is sclerosed. The epithelial layer is not thickened, but some of its cells have undergone colloid degeneration. Bowman's layer is wanting. In its place lies a tissue, known as pannus-tissue, consisting of round cells and some blood-vessels. Descemet's membrane is very thin, and at some places it is broken. Its endothelium cannot be distinguished; it may, however, only be covered by the masses of detritus, which adhere to Descemet's membrane.

The sclerotic is very thin.

Before describing the conditions of the corneo-scleral staphyloma, I must say that I apply in the following that name to what, after Schiess-Gemuseus, has been called *Staphyloma intercalare*. My reasons therefor will be spoken of later.

In this eye, the corneo-scleral staphyloma has progressed farther in the upper part of the corneo-scleral junction than in

the lower. In the upper parts, the tissue of the corneo-scleral junction is very much thinned and bulging. The inner margin of this bulging part is uneven, and looks as if it were the bottom of an ulcer. It is lined with uveal pigment which, at several places, projects into the corneal tissue. The posterior boundary of this bulging part is the insertion of the ciliary body, the anterior is formed by the iris, which is attached to the corneal tissue with a broad basis. The blood-vessels of the iris, which are no longer in direct connection with the ciliary body, are partially obliterated. Its uveal layer is very broad, the only remains, perhaps, of a former inflammation. Anteriorly to this new insertion of the iris (in transverse sections), the endothelium of Descemet's membrane seems to contain pigment.

In the lower half of the corneo-scleral junction the conditions are different. The iris is yet in connection with the ciliary body, but its periphery is to a small distance firmly attached to Descemet's membrane, so as to obliterate what is called the angle of the iris (Fontana's spaces). Between iris and Descemet's membrane, there lies a small layer of tissue, consisting of long delicate spindle-cells. The endothelium of Descemet's membrane and the anterior surface of the iris are wanting, and the new-formed tissue reaches farther forward upon Descemet's membrane than the attachment of the iris, and is pigmented.

Plane-views of Descemet's membrane explain the pigmentation of this part of the new-formed tissue and the endothelium differently. What in transverse sections appeared to be endothelium, is the new-formed connective tissue, which is filled with pigment-cells, star-like and with offshoots just as the pigment-cells of the uveal parenchyma. They are varying in form and size, have one or more light nuclei, and show all conditions which are considered to prove cell-proliferation. The nearer the iris, the more pigmented they are. It appears to me that the new-formed connective tissue is the result of a transformation of the endothelium, both of Descemet's membrane and of the anterior surface of the iris.

The ciliary body is very much stretched. Its muscular

fibres are all longitudinal. Its blood-vessels are filled. The anterior part of the detached vitreous body is firmly attached to the ciliary body, and the uveal pigment of the latter shows excrescences, such as Schiess-Gemuseus has described. These conditions I consider to be the result of a former cyclitis.

The detachment of the vitreous body has not been caused by new-formation of connective tissue in it, but by a large serous exudation into the posterior part of the vitreous chamber.

The circumscribed inflammation of the corneo-scleral tissue, which has been described by *Raab* (See Zehender, Klin. Montsbl., 1876, Jan. and Feb.) and earlier writers, is entirely wanting in this eye. The blood-vessels in this part may perhaps be increased in number. They are filled; the surrounding tissue, however, does not show any immigration or formation of round-cells.

While Schlemm's canal in the upper (the more staphylomatous) part is obliterated, it is well preserved in the lower half of the corneo-scleral junction.

To the foregoing I would add the results of seven more examinations of eyes affected with corneo-scleral staphyloma. They are all from Dr. Knapp's collection. Some of them, as it will be seen, will enable us to learn how this process begins.

II. The eye was enucleated with the suspicion of an intraocular tumor by Dr. H. Knapp. Patient had been treated for some time for a very severe acute iritis with frequent spontaneous hemorrhages into the anterior chamber. The inflammation then became chronic, there was constant increase of intraocular pressure, and the globe became ectatic. The interior of the eye never, *intra vitam*, could be examined. Besides changes in the posterior parts of the eye, which are unimportant for the purpose of this paper, I found the following conditions in its anterior portion.

The anterior chamber is filled with blood and pus. The cornea is thinned, the periphery of the iris is attached to it, the pupil is closed.

Microscopical Examination.—The parenchyma of the cornea is dim and partially sclerosed. Epithelium, Bowman's layer,

and Descemet's membrane are normal. The endothelium of Descemet's membrane is invisible because of the adherent blood and pus. The insertion of the iris into the ciliary body is still existing; the periphery of the iris, however, is for some distance attached to the corneal tissue, by means of a very thin layer of new-formed connective tissue, which reaches farther forward upon Descemet's membrane than the attachment of the iris. These parts have not, as yet, been very much stretched, which is evident since the attached iris is not yet atrophied. The iris is inflamed, and its thickened uveal pigment firmly adherent to the anterior lens-capsule. Its blood-vessels abound with blood, and the surrounding tissue is filled with round cells. The ciliary body also is firmly attached to the sclerotic, and atrophied in consequence of a former cyclitis.

The tissue of the corneo-scleral junction is normal, Schlemm's canal well preserved.

III. This eye was enucleated by Dr. Mooren. It is ectatic in all its diameters. The upper part of the corneo-scleral juncture is more staphylomatous than the lower.

The cornea shows the results of an ulcerative process: pannus-tissue, scar-tissue, want of Bowman's layer, and thickened epithelium. This thickening does not implicate the basal cells. The outer layers are partially horny, partially colloid. Descemet's membrane is thin, its endothelium partially wanting. Schlemm's canal does not exist.

The corneo-scleral staphyloma being very far advanced in the upper part, the following description is taken only from the less advanced lower parts:

The periphery of the iris adheres to the corneal tissue by means of the same delicate connective tissue which we have seen in the preceding cases. Descemet's membrane is visible between iris and cornea a short distance only from the insertion of the ciliary body. This part of the corneo-scleral tissue, where Descemet's membrane is wanting, is very thin and stretched; the attached iris is atrophic. There is no trace of an inflammatory process in the tissue of the corneo-scleral junction. The free part of the iris shows the results of chronic

inflammation, decay of the pigment-cells, new-formation of connective tissue, thickening and offshoots of the uveal pigment. The ciliary body is atrophic. The zonula Zinnii is detached, and the shrunken lens is dislocated into the vitreous chamber.

Retina and choroid show similar pictures as in case No. 1. The optic nerve is cupped.

IV. This eye was enucleated by Dr. Knapp.

It is ectatic in all its diameters (antero-post. diam. 34 mm.; horizont., 29½ mm.; vert., 30 mm.). The corneo-scleral staphyloma is annular.

There is old scar-tissue in the corneal parenchyma, and Bowman's layer wanting. The corneal epithelium, Descemet's membrane and endothelium are normal. Schlemm's canal does not exist. The sclerotic is very thin.

The periphery of the iris is attached to the cornea, but the interposed connective-tissue is wanting. The region of the attachment is stretched to such a degree that only the uveal pigment has escaped the atrophy of this part of the iris. It sends offsets into the corneo-scleral tissue. The membrane of Descemet is no longer in connection with the ciliary body. Its periphery lies under the new insertion of the iris into the cornea. Also the free part of the iris is atrophic. It has neither blood-vessels nor pigment-cells, and its uveal pigment shows some offshoots. The condition of the ciliary body is similar.

V. This eye was enucleated from a negro by Dr. Knapp. There is a large ciliary staphyloma in the upper half, a corneo-scleral staphyloma in the lower. The remaining parts of the globe are not ectatic; the optic nerve is cupped.

The cornea shows pannous and scar-tissue. Bowman's layer is wanting. In the centre, Descemet's membrane is broken, and the iris is adherent to the cornea. The wound-lips of Descemet's membrane are bent backward upon the iris; their endothelium, changed into long spindle-cells, is united with the endothelium of the anterior surface of the iris. Schlemm's canal is preserved. Its surroundings are somewhat pigmented.

The periphery of the iris is adherent to the cornea by means

of the above-described tissue, which extends farther forward upon Descemet's membrane, and is pigmented, as in case No. 1. The periphery of Descemet's membrane lies under the new insertion of the iris, upon the cornea. The attached part of the iris is totally atrophied, the remaining parts in a lesser degree. The blood-vessels of the free iris are empty. The uveal pigment is thickened. The ciliary body near the corneo-scleral staphyloma does not show any inflammatory process; the ciliary staphyloma in the upper half, however, could not have been formed without preceding cyclitis.

VI. This eye was extirpated with a cancroid tumor of the orbit. It is ectatic in all its diameters. Cornea and sclerotic are thin. The retina is detached. There is an annular corneo-scleral staphyloma.

The corneal parenchyma is transformed into scar-tissue. Bowman's layer is wanting. The anterior chamber is filled with gelatinous exudation, which does not admit of an examination of the endothelium of the otherwise normal membrane of Descemet.

The periphery of the iris is attached to the corneo-scleral tissue, and stretched with it. The union is accomplished by the same spindle-cell tissue as in the cases above. Schlemm's canal is wanting. The periphery of Descemet's membrane lies under the new insertion of the iris into the cornea. The attached part of the iris is atrophied. The parenchyma of the entire iris shows an abnormal quantity of round cells. Its pigment-cells are decaying. The uveal pigment is thickened, and at several places attached to the anterior lens-capsule. The ciliary body is also atrophied. In it and in the iris remains of hemorrhages are found. A former cyclitis is moreover recognized by a plastic exudation between the fibres of the zonula and some proliferation of the ciliary part of the retina.

VII. This eye, ectatic in all its diameters, has an annular corneo-scleral staphyloma, which is the farthest advanced in the upper half.

The cornea is sclerosed. Schlemm's canal is preserved, the tissue surrounding it somewhat pigmented. Only the uveal

pigment of the iris lines the bulging corneo-scleral part inwards. The other parts of the adherent periphery of the iris are entirely atrophied. Between the new insertion of the iris into the cornea and Descemet's membrane (the periphery of which lies here), is the above-described spindle-cell tissue. The free part of the iris is atrophic, and shows remains of parenchymatous hemorrhages. Its blood-vessels are mostly empty; its uveal pigment is very broad. The ciliary body is very much stretched; it is atrophied, but not inflamed.

The shrunken lens is dislocated backward. Retina and choroid are atrophic; the sclerotic is very thin.

VIII. This eye, enucleated by Dr. Mooren, has also an annular corneo-scleral staphyloma, which is the most pronounced in the upper half.

The cornea, partially transformed into scar-tissue, is conical and very thin in its centre. Bowman's layer is partially preserved. Descemet's membrane is normal. In its central part the endothelium is wanting.

The periphery of the iris is attached to the corneo-scleral tissue in the manner above-described, and entirely atrophic. The periphery of Descemet's membrane lies under the new insertion of the iris. The free part of the iris, as well as the ciliary body, are atrophied. Schlemm's canal is well preserved.

Conclusion.

The results of the foregoing examinations are the following:

The origin of the process is an inflammation of the iris or ciliary body, or of both, and not of the corneo-scleral tissue. The inflammation is not confined to the angle of the iris alone; later, it spreads over the fibres of the ligamentum pectinatum and their endothelium, and thus is carried over to the periphery of Descemet's membrane and its endothelium. The latter, as well as that of the anterior surface of the iris, proliferates, and by this proliferation a peripheric adhesion between iris and corneo-scleral tissue takes place. The proliferation of the

endothelium of the anterior surface of the iris has been thought possible by Raab,* but has not been proven.

The conditions which I found in the two eyes of negroes (Cases I. and V.), leave no doubt that in this way the tissue is formed which connects iris and cornea with each other. This interposed tissue has first been described by Schiess-Gemuseus † as "Intercalarmasse" (interposed tissue).

The circumscribed inflammation of the tissue around Schlemm's canal, which has been spoken of by Arlt, Schiess-Gemuseus, Raab, and others, did not exist in any of the above described cases. If this were the origin of the corneo-scleral staphyloma, it would certainly be found in cases where the process is just beginning.

Stellwag ‡ says that, in consequence of an excessive hyper æmia, the inner walls of the venous plexus might burst. This then would lead to the attachment of the iris and the formation of a staphyloma. If Stellwag could prove this occurrence, it would be the most simple explanation.

There is one condition, however, which by all the former writers on this subject has been either overlooked or not estimated as it should. I mean the condition of Descemet's membrane itself. In the first stage of the process, when only the attachment of the iris has just taken place, Descemet's membrane, ligamentum pectinatum, and the insertion of the ciliary body are in normal connection. Somewhat later, the periphery of Descemet's membrane lies farther forward toward the corneal centre. It thus appears that its most peripheral part has been consumed in the inflammatory process. The elastic membrane is now replaced by the tender tissue of the iris, which adheres to the corneo-scleral tissue, and this part is now no longer strong enough to bear even the normal intra-ocular pressure. The consumption of Descemet's membrane is

* Zehender, Klin. Montsbl., 1876, Jan. and Feb. Buphthalmus congenitus, Fr. Raab.

† Graefe's Archiv, IX., 3, p. 177. Zur pathologischen Anatomie des Keratoglobus, Schiess-Gemuseus.

‡ Lehrbuch der practischen Augenheilkunde, Wien, 1870, p. 387.

always in proportion to the so-called "growing forward" of the insertion of the iris, which latter has been very well described by Raab. In every case where the bulging of these parts is pronounced, the periphery of Descemet's membrane lies under the new iris-insertion.

Later on, inflammatory processes develop in the posterior parts of the eye, which almost always cause an increase of the intraocular pressure. Thus the staphyloma grows, and the globe is finally led either to total ectasia, or, as Schiess-Gemuseus has described in one case, to total atrophy.

It will now be evident why I avoided the name of staphyloma intercalare, which is used by the former writers in different meanings. Schiess-Gemuseus, who first described the newformed tissue which is "interposed" between iris and Descemet's membrane, never used this name himself. The interposed tissue and its formation is not at all characteristic of, or confined to, this process in the corneo-scleral region, and has been described by many authors in processes totally different from the one now under discussion. Characteristic of this process is only that it originates in the anterior parts of the uveal tract and involves later the *tissue of the corneo-scleral junction.*

It therefore appears to me the most natural to speak of a *corneo-scleral* staphyloma, as we speak of a corneal, scleral, ciliary, etc., staphyloma.

IX.

A Case of an Intraocular Granuloma Traumaticum of the Optic Nerve.

The eye in which I found the aforesaid affection was enucleated by Dr. Knapp after having been injured, and caused sympathetic irritation of its fellow. The conditions of the globe have been described in my paper on the Anat. Causes, etc., of Symp. Ophth. under No. 1. (Volume V., page 395.) As far as I know, an intraocular granuloma of the optic nerve has not yet been described. I therefore think it worth a

more detailed description than I possibly could give in the above named paper.

Macroscopic Examination.—From the entrance of the optic nerve a tumor proceeds into the vitreous chamber. Its basis is somewhat broader than the "head" of the optic nerve. (See Fig. 14, Plate VII.) The size of the whole tumor is that of a coffee-bean. It is surrounded by coagula of blood and fibrine, and seems itself to be traversed by hemorrhages.

Microscopic Examination.—The parts of the retina surrounding the basis of the tumor participate in its formation, more, however, in their inner than in their outer layers.

The tumor itself consists of cells, connective tissue, and blood-vessels, and shows many hemorrhages. The connective tissue, as well as the blood-vessels, take their origin directly from the "head" of the optic nerve. This can be traced easily. The cells of the tumor are mostly very small spindle-shaped cells, with an oval nucleus; they are mixed with round-cells. The nucleus of the spindle-cells is granulated. Red blood-corpuscles in all stages of decay are lying between these elements of the tumor.

While the tumor was growing, it apparently drew the adjacent parts of the retina more forward towards the centre of the globe, thus producing a detachment of the retina around the papilla. Into the space thus formed between retina and choroid, the granulation tissue has grown also, and it surrounds the retina from the inner and outer sides. Some blood-vessels of the choroid send branches into this part of the tumor.

The periphery of the tumor is not well defined. It passes over into the above-said coagula of blood and fibrine. Cells like those of the tumor lie along the threads of fibrine.

The retina and choroid surrounding the basis of the new-formation are filled with round cells. Moreover, there are numerous hemorrhages in the retina. The blood-vessels of the choroid abound with blood. Their walls are very much thickened and sometimes hyaline. Of their normal structure only the folded intima is recognizable. The optic nerve on the whole is atrophic, its connective tissue hypertrophied.

The occurrence of this interesting new-formation may have been caused by a direct injury to the papilla. Perhaps it is the transformation of a large hemorrhage into the vitreous body (V. Pagenstecher) which only later involved the optic nerve in the way above described. Perhaps, also, the anatomical conditions of this eye may give an explanation of the case of new-formation of vessels in the vitreous as described by O. Becker.* It seems, to me at least, that the drawings of the ophthalmoscopic image, as well as the description indicate a new-formation of tissue in the vitreous body, which is in connection with the papilla.

Similar cases are described from a clinical standpoint:

Jaeger's Atlas, page 141.

Geo. Strawbridge: Connective-tissue growth in the vitreous humor. Page 304, Transactions of the Amer. Ophth. Soc. 1875.

Manz: *Retinitis proliferans* in Graefe's Archives, Vol. XXII., page 229.

X.

On an Uncommonly Large Hemorrhage into the Parenchyma of the Choroid.

The eye has been removed by Dr. T. R. Pooley.

Patient stated, when first examined, that his left eye had been blind for some time. If an injury had occurred to it, he did not know. There were ulcerous keratitis and irido-cyclitis, with very severe pain. The continual irritation and pain in the blind eye finally induced the doctor to remove the eye. There was no sympathetic affection in its fellow. An ophthalmoscopic examination was impossible.

Macroscopic Examination. (See Fig. 15, Plate VII.)—The cornea is flat, irregular in thickness, and apparently changed into scar-tissue. The entire iris adheres firmly to Descemetic membrane. Behind it is a small portion of lens-substance. The ciliary body seems broader than common. The

* Ueber Gefässneubildung im Glaskörper. Wiener Jahresbericht.

choroid is (in a meridional section) on one side in toto detached from the sclerotic by a large hemorrhage. The opposite part of this membrane is separated by a hemorrhage into two layers. The retina lies on one side normally upon the detached choroid, on the opposite side these membranes are separated by a serous exudation. The optic nerve is cupped. The remainder of the vitreous chamber is filled with the same serous exudation. The sclerotic, at several places very much thinned, is thicker than normal in its posterior parts.

Microscopic Examination.—The corneal epithelium is not uniformly thick. The centre of the cornea is formed by a broad cord of scar-tissue. The margins of the scar are ragged and the scar-tissue has grown between the adjacent lamellæ of the cornea in such a way, that it is much more probable that the scar is the result of an ulcer than of an injury. Descemet's membrane, moreover, as far as it would have formed the bottom of this ulcer, lies on the one side in the canal of the scar, and reaches nearly the epithelium which covers these parts. The margin of Descemet's membrane on the other side coincides with the margin of the scar. Probably there existed a so-called myocephalon (bulging of Descemet's membrane) in consequence of the large ulcer, and this was finally ruptured on one side and thrown into the canal formed by the ulcer. With Descemet's membrane the iris was pushed forward and filled about one-third of the canal of the scar. The scar-tissue itself is of the common structure. The surrounding parts of the cornea are filled with cells and hemorrhages. The periphery of the cornea is covered with pannus-tissue.

The iris, which is totally attached to Descemet's membrane, is partially thinned and atrophic, partially thicker and filled with round cells. Its uveal pigment is much broader than normal. There is no trace of the sphincter muscle.

The remains of the lens, which adhere to the posterior surface of the iris, are granular (fatty) or entirely decayed. They are surrounded by the folded capsule, upon which no epithelium is found. The whole lens is surrounded by coagula of blood and fibrine.

The ciliary bodies are full of round cells and hemorrhages. Blood fills their posterior third in such a degree as to crowd their fibres asunder. Their blood-vessels abound with blood. The ciliary nerves are here unchanged.

That part of the retina, which is detached in toto, shows similar conditions near the ciliary body. Its normal structure is unrecognizable. Near the optic nerve the hemorrhagic infiltration is not quite as dense, and now and then a blood-vessel and some pigment-cells are found. These blood-vessels are filled. Between the red blood-corpuscles in the infiltrated parts lies an unusual number of white round cells.

The parenchymatous hemorrhage has separated the choroid in such a way as to push the vascular part of this membrane towards the centre of the eye, while its outmost connective-tissue layers remained adherent to the sclerotic. These conditions may, perhaps, prove the layers of endothelium, recently described by Sattler (Graefe's Archiv), as dividing the choroid into different lamellæ. The lamina vitrea is well preserved. The severed parts of the choroid are filled with red and white blood-corpuscles.

One of the sections happened to strike the entire course of a ciliary nerve where it pierced the sclerotic. The nerve itself is pervaded by blood-vessels, the vessels surrounding it are hyperæmic, the nervous elements, however, are normal. Along the canal of the nerve the sclerotic is filled with pigment-cells of the uveal tract (?). Another nerve canal is filled with extravasated blood.

The retina has undergone connective-tissue degeneration. Only near the opticus some blood-vessels are found in it. Between the connective tissue much pigment is found.

The optic nerve is cupped. In the excavation lies a small amount of blood and fibrine. The trabeculæ of connective tissue of the optic nerve are very broad. The nervous elements are scarce and partially dimmed by fatty infiltration.

In a paper on the healing-process after iridectomy (these ARCHIVES, Vol. IV.), I reported a case of a similar splitting of the choroid into lamellæ, by a parenchymatous hemorrhage.

In the human eye I have never before found a similar condition, and I therefore thought this case to be of some interest.

XI.

Three Cases of Traumatic Granuloma of the Iris.

Among the tumors of the iris, von Wecker speaks of the "granuloma iridis traumaticum" (V. Graefe and Saemisch, IV. p. 548), and cites the literature concerning this new-formation. The following three cases of this affection bear some particular points of interest:

1. Pat. M. H., æt. 18 years, suffered from variola about five months previous to her entrance to the hospital. She stated that during her illness both eyes had been inflamed several times. After these inflammations had passed away, there remained, lying upon the lower half of the right cornea, a small grayish body which, from that time, grew steadily, without any inflammatory reaction. When examined, the tumor was of the size of a pea, and so translucent as to prompt the diagnosis of a cystic tumor. By the use of a probe, it was found that the tumor adhered to the cornea with a broad basis. The condition of the iris and its relation to the tumor could not be recognized.

The tumor was cut off by Dr. Knapp in a manner similar to the operation for partial staphyloma. The cornea under it was somewhat excavated. The iris-tissue, which formed the bottom of this excavation could not be removed, being too firmly connected with the cornea. It was then evident that we had to deal with a prolapse of the iris.

The following is the result of the microscopical examination of the tumor:

The broad basis of the tumor is formed by iris-tissue, which, as yet, is very little changed. In its centre the pigment-layers of the posterior surface of the prolapsed fold are united, and form a broad streak of dark pigment. The iris-tissue, which surrounds this pigment-streak, spreads forward like a fan.

The farther from the centre, the more irregular and scarce is its pigment. It finally fades away into a granulation-tissue, which contains only some free pigment-granules. The iris-tissue is filled with round cells, and has only a few vessels, some of which extend into the granuloma. The latter consists of apparently young round cells, having only a small amount of protoplasma around the nucleus, some free nuclei, a number of small spindle-cells, and very little connective tissue. In some of the sections remains of the sphincter muscle are found. Its fibres participate in the new-formation of round cells ; their protoplasma is decaying.

The surface of the tumor is covered with a thick layer of epithelium, which takes its origin from the corneal epithelium, and shows all its different layers. On the cornea the layer of flat cells is thicker than normal.

II. The history of the eye from which I took the specimen which shall be spoken of in the following, can be found under case VI., among the cases of sympathetic neuro-retinitis in my paper read before the International Congress of Ophthalmology (See Transactions). I there reported that a tumor grew from the place where the eye had been injured. It was considered to be a staphyloma, and was cut off by Dr. Knapp.

The following are the microscopic conditions of the tumor, which had about the size of a pea, and was also a granuloma of the iris :

In the centre of the basis of the tumor, some remains of iris-tissue are found, containing many round cells. The pigment-cells of the parenchyma are destroyed. The iris-tissue goes over into granulation-tissue in the same way as in case No. I. The granuloma consists of round cells which are crowded together without being mixed with any spindle-shaped cells or traversed by connective-tissue. Some of the blood-vessels of the iris pass over into this tissue. The round cells vary in size. They are somewhat shrunken by the hardening fluid, and therefore smaller than usual. Their nucleus is either small and surrounded by much protoplasma or vice versa. Many of the cells have taken up some granules of the pigment, which be-

came free by the destruction of the pigmented cells of the iris.

The margins of the cornea surrounding the tumor were cut off with it. They abound with round cells, their lamellæ are decaying. Descemet's membrane is bent outward, its endothelium participates in the new-formation of cells. Corneal epithelium covers the entire surface of the tumor.

III. The following case bears the more interest, as it corresponds fully to the drawing in the atlas of H. Pagenstecher and C. Genth of a tumor which is called there a granuloma corneæ. (See Plate XII., Figs. 1 and 2). It is to be regretted that, in the description of the specimen, nothing is said about the conditions of the iris in this case. But it appears from the macroscopic drawing (Fig. 1), that the iris was totally adherent to the posterior surface of the cornea. In the drawing of the microscopical appearance, the cornea has been left off.

Saemisch* says: "The tumors observed on the cornea are not to be considered as originating in the tissue of the cornea itself, etc." Having examined a number of such tumors myself, and being acquainted with the literature on this point, I am forced fully to agree with Saemisch and to doubt the diagnosis of a granuloma of the cornea, the more so as the following doubtless case shows the same conditions which have been drawn by Pagenstecher in the case above mentioned.

The globe was enucleated by Dr. Knapp.

A flat tumor is found at the periphery of the cornea, which overlaps the corneo-scleral junction. The tumor is connected with the cornea by a thin pedicle. A section through the centre of the tumor and pedicle explains the conditions in the following manner (See Fig. 16, Plate VII.).

The greater part of the new-formation consists of round cells, among which here and there some small spindle-cells and some connective tissue are found. The round cells are somewhat larger than in case No. 2, but show the same particulars. They are crowded together, the densest near the periphery.

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* Graefe and Saemisch, Vol. III., p. 308.

The tumor is pervaded by numerous vessels arranged like radii. No epithelium covers the surface of the new-formation. The pedicle consists of connective tissue and blood-vessels. A streak of decayed pigment-cells lies in its centre.

In following up the pedicle towards its origin, it is seen to pierce the whole thickness of the cornea, and passing over on one side into the pupillary edge of the iris, on the other into the ciliary body. Its blood-vessels, connective tissue, and pigment originate in these parts of the iris. The latter abound with round cells.

The uveal pigment of the iris, as far as it lies in the globe, is much broader than normal, and spreads into a tissue of round and fusiform cells. The pupil is occluded by new-formed tissue to which the folded capsule of the lens is firmly attached. The capsule (corresponding to the prolapse) had been injured, and the margins of the wound are retracted. The new-formed cyclitic tissue has entered the lens-capsule and reaches farther than the vertical meridian. The remainder of the lens-fibres are either totally decayed or very much infiltrated with fat.

In the canal of the corneal wound, the tissues of both the iris and the cornea manifest a perfect union. The corneal epithelium has begun to grow upon one part of the tumor. Descemet's endothelium is transformed into spindle-cells.

Though every clinicist has frequent opportunity to see such cases, only a small number of traumatic granuloma of the iris has as yet been histologically described. (See von Wecker, *ibidem.*) I therefore thought the publication of the foregoing three cases not to be entirely useless.

XII.

Hemorrhagic Iritis with Spongy Exudation.

This globe, in general, has been described in my paper on sympathetic ophthalmia (These ARCHIVES, V. 3 and 4), where I shortly mentioned the condition here specially to be considered.

Since I observed the case before the enucleation, and cannot find (in the literature at my disposal) an anatomical report

of such conditions, I think a more extensive description will be justifiable.

Some time previous to the first examination, the globe had been injured in the ciliary region. The ensuing inflammation and sympathetic symptoms in the fellow-eye necessitated its removal. The day before the enucleation was performed, a "spongy" exudation (Knapp, Gruening) was seen in the anterior chamber. It was, as common (Schmidt, Gruening), lens-like in shape and dimension.

Microscopical Examination.—The blood-vessels of the iris abound with blood, and are tortuous. There are many white blood-corpuscles in the parenchyma of the iris and in the tissues forming the "angle of the iris." Along the blood-vessels, in which it is impossible to detect any rupture, are small and large parenchymatous hemorrhages. They are the largest and most numerous in the region of the circulus iridis major. The uveal pigment is very much thickened, apparently proliferating. The endothelium of the anterior surface of the iris is very thin, and bears a small layer of round cells.

The exudation, which lies in the lower part of the anterior chamber, has two well-defined parts. The one, perfectly homogeneous, like the gelatinous exudations, lies near the cornea and in the "angle of the iris." The other, lens-like in shape, consists of a minute network of exceedingly fine threads of fibrine, the meshes of which, during life, were probably filled with exudation. Here and there a single round cell may be found in them. The network has sharp outlines where it is surrounded by the gelatinous substance. Its fibrillæ may be traced backward, between the endothelium of the anterior surface of the iris, and thus form a firm union between the exudation and the region of the circulus iridis major.

These anatomical conditions explain fully what has been observed by the clinicists. The two layers are the two subsequent stages of exudation, described as being first "spongy" (Knapp, Gruening),* and then "gelatinous" (Gunning).†

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* These ARCHIVES, Vol. III., pp. 22 and 23.

† Cf. Zehender, Klin. Mtsbl., 1872, p. 7.

During the year 1876, I observed this spongy exudation in six cases. Besides the one just being spoken of, three times in specific iritis and twice in iritis after extraction of cataract. The similarity of the clinical picture of the affection with what is so frequently seen during the absorption of blood in the anterior chamber, gave me the idea that the spongy exudation might be caused by hemorrhages. The anatomical conditions of this case seem to prove it.

Supposed that, when a considerable hemorrhage occurs into the parenchyma of the iris, the plasma of the blood is filtrated through the iris-tissue into the anterior chamber (See Kniess, Virchow's Archiv), and the fibrine coagulates there, then we would find the "spongy" exudation. If it is dissolved before being absorbed by the cornea (cf. Kniess, *ibid.*), we would find the "gelatinous" exudation.

It thus appears to me that the occurrence of a spongy exudation may prove a hemorrhagic iritis. This is the more probable, since spongy exudation is found especially in specific iritis and in iritis after operations (cf. Gruening, *ibid.*).

EXPLANATION OF FIGURES 13 TO 16, PLATE VII.

FIG. 13. Fibrous degeneration and union of retina (R) and choroid (Ch). (IZ) a zone of infiltration surrounding the connective-tissue.

FIG. 14. (Gr) Granuloma, (R) Retina, (Ch) Choroid, (Scl) Sclerotic, (Opt) Optic Nerve.

FIG. 15. (Hæ. I.) Hemorrhage between sclerotic and choroid. (Hæ. II.) hemorrhage in substance of choroid, splitting it into two lameliæ.

FIG. 16. (Gr) Granuloma of the iris, (C) cornea, (D) Descemetii, (Ir) Iris, (Cc) Corpus Ciliare, (LK) Lens Capsule.

(*To be continued.*)

A CASE OF ENDOTHELIOMA OF THE INTERVAGINAL SPACE OF THE OPTIC NERVE. REMOVAL WITH ATTEMPT TO PRESERVE THE EYE-BALL. SUBSEQUENT ENUCLEATION ON ACCOUNT OF UNCONTROLLABLE HEMORRHAGE. REMARKS.

By Dr. ADOLF ALT, M.C.P.S.O., of Toronto,

Lecturer on Ophthalmology and Otology to the Trinity Medical School.

While being in Montreal to attend the meeting of the Canadian Medical Association, I was asked by my friend, Dr. Desjardins, to see one of his patients, at the Hôtel Dieu of Montreal.

After examination, we agreed upon having before us a case of tumor of the optic nerve, and decided to remove it, if possible, with preservation of the eyeball. Since the number of recorded similar cases is as yet small, and the one under consideration shows some new clinical as well as histological features, I herewith bring it before the profession.

The history of the case, which was kindly furnished me by Dr. Desjardins, is the following :

George Phaneuf, æt. 31 years, laborer, of Redford, Clinton Co., N. Y., perceived the first signs of protrusion of his left eyeball six years ago. Previous to that time he had not noticed any failing of sight in that eye. Only some time after the eye had begun to protrude, he felt a diminution of sight, which gradually became worse. Only the one year preceding the examination has the eye been totally blind.

Three years since, after the patient had frequently suffered from intense headache and ciliary pain, he at once was taken by epileptic fits. At first these fits recurred every four or five weeks ; they, however, soon became more and more frequent, so that he had a fit nearly every day, on some days even three or four. In the spring of 1877, he was treated for epilepsy, and the frequency of the fits gradually diminished. When he ceased treatment, they occurred only about twice a week. Soon, however, things returned to their old state, and no treatment was administered until he entered the Hôtel Dieu, on the 5th of September,

1877, to seek relief from the excruciating pain he suffered in and around his protruding eyeball. Dr. Desjardins, under whose care he came, at once put him under the influence of bromide of potassium and up to the day of the operation he had only two epileptic seizures. The pain, however, remained unaltered.

When I saw the patient, on the 12th of September, 1877, I found the following *status præsens.*

Patient is a well-built, strong, and healthy-looking man. The left eye is protruding straight forward from four to five lines. The motility of the globe is a little diminished in all directions. The eyelids can no longer be closed over the eyeball. By palpation a roundish tumor is felt at the inner angle, upwards and downwards. This tumor moves with the globe and seems to be separated from the walls of the orbit by compressible tissue. When the patient stoops, the protrusion remains unchanged, nor does pressure upon the globe materially alter its position. Neither the patient nor the examining physician can detect any vascular noises. Tn.

The ophthalmoscope reveals total atrophy of the optic nerve. There exist no other pathological conditions in the media or background of the eye. V=O.

History and status præsens of the case led us to the diagnosis of a tumor of the optic nerve. The patient, who was suffering from intense pain, begged to have an operation performed. There was one point which caused us to hesitate somewhat, *i. e.*, the epileptic fits. It remained questionable whether these seizures were caused by the primary tumor of the optic nerve, or by metastasis in the cranial cavity, or whether they were not at all connected with the tumor, being an independent disease. The otherwise healthy condition of the patient, and the fact that his mental functions were in no way interfered with by the disease, brought us finally to resort to an operation, and we agreed upon the removal of the tumor, if possible, with preservation of the eyeball. At all events we hoped thus to alleviate the patient's pain, and, perhaps, the removal of the tumor would act favorably upon the epilepsy.

Dr. Desjardins was kind enough to ask me to perform the operation and I did so on the following day, September 13th, with his kind assistance, and in the following way:

After I had, on examination, found the patient's heart to be normal, he was perfectly anæsthetized. The wire-speculum inserted, I cut the

conjunctiva and Tenon's capsule between the insertions of the superior and internal recti muscles so far that I could enter with the forefinger of my left hand and explore the conditions. I felt the tumor as a more or less cylinder-shaped mass, not quite reaching the sclerotic anteriorly, whilst posteriorly it seemed to extend to the very apex of the orbit. Guided by my finger, I then tried by means of strabismus scissors to free the tumor gently from its surroundings. Seeing, however, that I advanced but very slowly, I severed the optic nerve from the globe. This I afterwards was very sorry for, and if ever I have to perform a similar operation again, I shall go on cautiously, and cut the nerve first posteriorly. After the nerve was severed from the sclerotic, the tumor collapsed, and it was very difficult to get a hold of it. I finally succeeded in grasping it with a pair of forceps, and now freed it from the surrounding tissue. When reaching the apex of the orbit, I felt the tumor entered the optic foramen. In order to remove as much as possible of it, I was thus obliged to act against the rule, and draw the optic nerve forward. I succeeded to get out the bulk of the tumor in one piece, but, what I had feared, a very considerable hemorrhage ensued. After it had diminished somewhat, I removed some roundish hard bodies from the orbital fat and the internal rectus muscle.

The macroscopic appearance of the tissue of the fresh tumor was very similar to that of fresh liver.

The condition of the epithelium of the cornea did not allow of an ophthalmoscopic examination after the operation. When the bleeding seemed to be arrested, I tried to reduce the exophthalmus by pushing the globe into the orbit. Yet, as I thought, owing to the infiltration of the orbital tissues in consequence of the hemorrhage, I could not reduce it. I therefore closed the lids over the eyeball with some sticking plaster, and applied a slightly compressing flannel-charpie bandage.

Having assisted to the similar operations of Dr. Knapp's case described in these ARCHIVES, Vol. V., 2, pag. 131) and Dr. Gruening's (these ARCHIVES, Vol. V., 3 and 4, p. 508), and having watched these cases very closely, being at the time house surgeon to the N. Y. Ophth. and Aur. Inst., I expected no further trouble, a kind healing, and gradual reduction of the exophthalmus.

My expectation, however, was deceived. Four hours after the operation, we were summoned to the Hospital. The patient had vomited and bled continually for nearly two hours, and suffered from severe pain. After the bandage was removed, we found the lids and the whole

circumorbital region extremely swollen, and bluish-black by suffusion with blood. On the top of the swollen parts was the now perfectly dislocated eyeball, hard like stone, and surrounded by intensely swollen conjunctiva, which looked perfectly black with blood. The blood flowed quite freely through the palpebral fissure. The fearful pain the patient was suffering, the impossibility to control the hemorrhage, and the otherwise nearly unavoidable gangrene of the involved parts induced us to abandon the idea of saving the eyeball. I at once removed it, and thus reduced the patient's sufferings considerably. I then ordered ice-applications, under which treatment the bleeding stopped during the following night.

Dr. Desjardins wrote me later that there was a slight fever for two days, but the pain and swelling rapidly subsided. About six weeks after the operation, he removed some granulations from the orbit, fearing there might be a relapse. About two months after the operation, the patient left the hospital strong and very contented with his improved condition. According to a letter from Dr. Desjardins, he had only three epileptic fits during three months after the operation.

Anatomical Examination of the Tumor and Eyeball.

The specimen was hardened in Müller's fluid. When I had severed the optic nerve from the sclerotic (during the operation) I left a piece of $2\frac{1}{2}$ mm. on the eyeball. This, added to the part taken up by the tumor and cut out during the operation, measuring 29 mm., gave the considerable length of the intraorbital part of the optic nerve to be $31\frac{1}{2}$ mm. Since the specimen, when measured, was hardened and more or less bloodless, it must have been longer yet before the removal. The normal length of the intraorbital part of the optic nerve is from 28 to 29 mm. (See *Merkel*, Graefe and Saemish, Vol. I., p. 17.)

A longitudinal section through nerve and tumor shows that the posterior part of the nerve (to an extent of 23 mm.) is perfectly lost in the tumor. The outer sheath of the nerve is perforated by the latter, and the new-formation thus entered the orbital fat and muscular tissue.

Microscopic examination shows that the tumor consists mainly of connective tissue, which forms alveoli filled with cells. Ac-

cording to the size of these alveoli, the clusters of cells are larger or smaller. When viewed with a low magnifying power, the appearance of the tumor is perfectly that of an epithelioma. Even pearl-nodules are not wanting. Seen with a high power, however, the appearance is somewhat different. Some of the alveoli seem to be filled with more or less oblong nuclei only. The latter are concentrically arranged, frequently around a shining corpuscle, arenoid bodies. In other alveoli it seems as if we had to deal with spindle-shaped cells arranged in the same way. Sometimes there lies in the centre of the alveolus a large granular body containing several nuclei. Some of the cells are filled with colloid substance, which pushes the nucleus aside. At the edges of the sections it appears as if the cells had some delicate offsets.

In teased specimens and with a high power, the true shape and nature of the cells are easily recognized. They are large, flat, membrane-like bodies, only a little thicker around the large oval nucleus. Some of them have delicate offsets; all, however, show strangely indistinct outlines. Between these cells with one nucleus, there are a number of giant-cells with from six to twelve nuclei, imbedded in very little protoplasma. Also cells with two nuclei are not unfrequent.

I think there can be no doubt as to the *endothelial* character of these cells.

In the larger part of the tumor, no nerve-fibres can be detected; they begin to appear only at the distance of about 7 mm. from the sclerotic. From here they increase in the direction towards the globe, as the elements of the tumor disappear. Very near the entrance of the optic nerve into the sclerotic, some clusters of cells lie in the intervaginal space. Where the nerve is free from the new-formation it is very thin. There is considerable hypertrophy of the perineurium and the outer sheath. The nerve-fibres are undergoing fatty degeneration. The hypertrophy of the connective tissue, and the destruction of the nerve-fibres is most marked in the region of the lamina cribrosa. The papilla is perfectly flat, but shows no excavation.

In the retina I found a considerable expansion of the veins

and here and there a ganglion cell in regressive metamorphosis, otherwise nothing abnormal.

Where the elements of the tumor had invaded the tissue of the internal rectus muscle, I found the conditions very similar to those drawn by C. Heitzmann, in Dr. H. Knapp's case: Large Orbital Sarcoma, etc. (these ARCHIVES, vol. V., p. 137), only that in my picture the remains of the striated muscular fibres lie between the concentrically arranged *endothelial* (there sarcomatous) cells. In other parts, the muscular fibres are changed into a molecular grumous mass, yet retaining their shape and color. Not unfrequently also they present the wax-like appearance which by *Zenker* was thought to be essential to typhoid myositis, by *Weil*, however, has been proven to occur after all sorts of injuries. The injury here was certainly the pressure exerted on the muscular fibres by the growing neoplasm.

Remarks.

A very similar tumor has only lately been described by *Schott* (These ARCHIVES, vol. VI., 1 and 2, p. 276). In fact, his drawings correspond so well with my specimens that I need not draw them again.

Schott is of the opinion that a number of tumors which have been described under various names actually belonged to the endotheliomata. Among the number of tumors taken into consideration by him, I miss the one described by *Knapp* as carcinoma of the outer sheath of the optic nerve (these ARCHIVES, vol. IV., p. 323). From the description of this tumor, and the specimens of the same I have in my collection, I see there is very little difference between these two new-formations, and I am inclined to count Knapp's tumor among the endotheliomata.

In connection with the foregoing history, the following questions may be of interest:

Was the epilepsy caused by, or in any way connected with, the tumor of the optic nerve? This question forced itself upon my mind as one of the most important suggested by our case. It is

impossible to say that the tumor caused the epilepsy, especially since we do not know how far back it reached into the cranial cavity. I think, however, that the tumor aggravated the epilepsy. Even if it did not reach far back into the cranial cavity, it must needs have exerted an indirect pressure upon the parts of the brain nearest to the chiasm. This is evident if we consider that the intraorbital part of the optic nerve, which in normal eyes is from 28 to 29 mm. long, measured in our case, when being bloodless and hardened, $31\frac{1}{2}$ mm. Before the operation it certainly was still longer, and though the exophthalmus showed that the nerve was pushed outwards towards the anterior opening of the orbit, the resistance of the muscles, conjunctiva, and lids must have pressed on the portion lying farther backwards. This opinion is certainly well supported by the rarity of epileptic seizures ever since the tumor was removed.

However, there might have been metastases in the brain, or the tumor might, as in *Schott's* case, have originated in the cranial part of the optic nerve. Metastases in similar cases have, as far as I know, not been reported; and again, the improvement produced by the removal of the intraorbital tumor, and the otherwise perfectly healthy condition of the patient, seem to prove that in the brain at least there were no metastases.

What caused the uncontrollable hemorrhage? When I found during the operation that the tumor entered the optic foramen, I considered it necessary to pull the whole new-formation forwards, and to remove as much of it as I possibly could. Though in doing so I acted against the rule, I considered it unavoidable from the foregoing reason. According to the anatomy of these parts, it is most probable that I cut the arteria ophthalmica, or certainly one of its larger branches. By the cutting at the very apex of the orbit, and by the removal of the smaller tumors from the orbital tissue, I had opened numerous canals through which the blood could be forced into the tissues around the orbit. I do, however, not know how I might have guarded myself against these emergencies.

Was it absolutely impossible to save the eyeball? I think that,

in spite of all that induced us to agree upon the subsequent removal of the eyeball, it might perhaps have been saved. Yet the question arose, whether it was more important to save the patient or the eyeball, and since the latter was certainly the minor object, we cannot be blamed for having removed it. There seemed to be no hope of being able to stop the hemorrhage (which was a very profuse one), and the patient suffered an agonizing pain caused by the constantly increasing pressure exerted by the infiltration with blood upon the nerves. If this pressure was going on to act upon the tissue—and it was sure to do so unless we were enabled to check the hemorrhage—gangrene was sure to supervene. By removing the eyeball, all these disageeable symptoms and prospects were done away with, and I am satisfied we acted rightly in doing so, instead of imperilling the patient for the sake of the eyeball.

Where did the tumor originate? The perfectly normal condicondition of the right eye seems to prove that the new-formation originated in some part of the optic nerve lying in front of the chiasm. It remains doubtful, however, whether it originated in the orbital or that portion of the optic nerve which lies between the chiasm and the apex of the orbit. The fact that the protrusion existed long before the eye became blind may prove that the tumor originated in front of the optic foramen. In the latter, it would certainly have compressed the nerve and destroyed it sooner than in the orbit, where it was surrounded by more or less compressible tissue.

The elements from which the new-formation started were probably the endothelial cells of the intervaginal space. It might have started also from the endothelial cells, which are found lying upon the trabeculæ of connective tissue which sever the fascicles of the optic nerve. This, however, is improbable, since such a condition would certainly have produced blindness before the protrusion could have been noticed.

Are there anv clinical symptoms which admit of a differential diagnosis between this and other kinds of tumor of the optic nerve? There is none to be recorded so far. When *Knapp* described his case of carcinoma of the outer sheath of the optic nerve, he

thought the intense pain his patient had suffered might be a valuable symptom as to the differential diagnosis. The same symptom, however, existed in *Gruening's* case of myxoma of the optic nerve, and in the case of endothelioma under consideration. *Schott's* case was only accidentally discovered in making the post-mortem on a patient having died from a disease of the liver, and there was no history with regard to the tumor of the optic nerve.

What is the prognosis in our and similar cases? From the few similar cases placed on record, it seems that we must count those tumors among the benign ones, at least *quoad vitam.* The patient of Knapp is living, and enjoying good health; so is mine, and in Schott's case the tumor had not even been suspected during life, though it concerned both optic nerves. If it is possible in such cases to remove the entire tumor, the prognosis therefor is certainly a good one. In my case it must remain somewhat doubtful, since we do not know what will become of that part of the new-formation which did not come within the reach of my scissors.

I may add here that the granulations which were removed from the orbit later did not contain pieces of the tumor, but were mere granulation tissue.

SIXTEEN CASES OF SARCOMA OF THE CHOROID, WITH EPICRITIC REMARKS.

By Dr. M. KNIES.

Translated by G. R. Cutter, of New York, Surgeon N. Y. Eye and Ear Infirmary.

(With two wood-cuts.)

Introductory Remarks.

The anatomical material of the following paper was collected by me several years since, and at various periods microscopically examined by several of my pupils. In the winter of 1870–1, Dr. George R. Cutter, of New York, since then more widely known as the translator of Frey's "Microscope" and "Histology," was occupied with the investigation of this subject. The material then prepared did not, however, seem to me sufficiently abundant to warrant its publication. In the year 1876, Dr. Chodin, of Moscow, continued the investigation, with special regard to the origin of choroidal sarcoma as a result of injuries to the bulb. On leaving Heidelberg, he left me, in addition to the corresponding preparations, complete descriptions of all the eyes examined by him, and which he wrote out in German after we had together looked over the preparations. It was my intention to revise and abbreviate these descriptions, add the necessary epicritic remarks, and publish them in connection with the eyes examined by Dr. Cutter. Obstacles to this project having repeatedly presented themselves, I gladly took advantage of the temporary presence of Dr. Knies in Heidelberg, and tranferred the work to him. Dr. Knies had already obtained the results of the examination of several eyes in connection with secondary glaucoma, and, in addition, examined three other eyes which I had recently received.

We have, then, together gone over the preparations left by Drs. Cutter and Chodin, compared them with their descriptions, and made use of the former as far as was possible. It has constantly been far from my intention, however, to limit Dr. Knies in any manner in the work which he has assumed. I have taken an interest in the matter only to the extent of being in complete accordance with the interpre-

tation of the microscopic results. Dr. Knies is essentially responsible for the epicritic remarks.

Thus, although late, Drs. Cutter and Chodin see the fruits of their diligent labor made manifest.

Dr. Cutter examined the eyes 1 and 2; Dr. Chodin, the eyes 3–9 and 12–15; Dr. Knies, the eyes 10, 11 and 16. PROF. O. BECKER.

The pathological anatomy of sarcoma of the bulb has already assumed considerable proportions in ophthalmological literature. Nevertheless, important questions, such especially as relate to their origin and expansion, are partly disputed, partly insufficiently understood. We hope that the increase which the literature receives from this work, through its sixteen carefully examined cases, may contribute somewhat to the solution of the above questions and some others.

The literature, as we have already said, is rather extensive; we would call especial attention, in addition to the communications of Von Graefe in various portions of his Archives, to: Knapp, The Intraocular Tumors, Karlsruhe, 1868; New York, 1869; Becker, Zur Diagnose intraoculärer Sarcome (these ARCHIVES, Vol. I., 2, page 214), and Brière, Etude clinique et anatomique sur le sarcome de la choroide et sur la mélanose intraoculaire; Thèse, Paris, 1873, the latter work containing a quite complete collection of the cases published from 1826 to 1872. With regard to casuistics, especial mention is to be made of Socin, Virchow's Archiv, Band LII., page 550; G. Berthold, Graefe's Archiv, Band XVII., 1, page 185; Landsberg, Hirschberg, Schiess-Gemuseus, etc. The Ophthalmic Hospital reports are especially distinguished for their rich and well-selected casuistics (Nettleship, Brailey, and others.)

In the first part of this work, we shall present the cases which have been observed and examined. They concern the most various stages of tumors, from the commencement to complete destruction of the bulb.

The first two cases belong to the commencement stage. Both individuals are still alive, and since the operation 6½ and 7½ years have passed. Of three other cases, in which, it is true,

glaucomatous manifestations had appeared, though the walls of the bulb were found still intact, or at least no perforation could be recognized, in one (No. 3) the cure was also permanent (now 10 years), while nothing satisfactory can be communicated concerning the two others. In cases 6–12, perforation had occurred, and extrabulbar tumors were present. Cases 11 and 12 especially present very far advanced stages. The course was, where known, correspondingly malignant.

Cases 13–16 present especial interest from the fact that their origin is to be ascribed with great probability to a trauma, and are, therefore, placed together in contradistinction to the common sarcomata, cases 1–12. In the second part, we shall attempt to draw some conclusions from what has been found in these 16 eyes, and compare our results with those of other investigators.

1 (297).* In November, 1869, Dr. Cl., a very respected citizen of Heidelberg, 51 years of age, came to the clinic complaining that, since the fall, he had noticed a diminution of the vision of the right eye. He is a hunter, and his attention was first called to the eye by his frequent failures in hunting. Left : S. $\frac{20}{20}$, with $-\frac{1}{60}$ a little more distinct ; right: S. $\frac{20}{50}$, with $-\frac{1}{60}$ S. $\frac{20}{20}-\frac{20}{30}$. Ophthalmoscopic, right refractive media quite clear. The contours of the papilla and vessels quite sharp. The only difference in the left eye was that the retinal vessels, especially toward the macula lutea, were more distinctly visible. The protocoll stated : "Retina somewhat hyperæmic."

Neither scotoma nor metamorphopsia were present ; therefore the cause of the impairment of vision in the right eye was left in suspense.

January 26th, 1870, the patient returned with the complaint that vision had grown worse, and he now noticed that, on observing certain striated objects (banisters, pickets, etc.), they were curved in a zig-zag manner. By closer examination, however, it was found there was no

* The figures inclosed in parentheses refer to the number of the preparation in Prof. Becker's collection. We gladly avail ourselves of this opportunity, in the name of the latter and ourselves, to render our hearty thanks to those gentlemen, who, through their friendliness, have rendered such a rich collection of pathological material possible, especially *Sanitätsrath* Mooren, of Dusseldorf ; Dr. Hirschberg, of Berlin ; Dr. Just, of Zittau, and Dr. Steffan, of Frankfort on the Main.

real metamorphopsia, but that there was present the familiar phenomenon (Helmholtz, Physiologische Optik, page 217) in which, under certain circumstances, parallel striæ appear sometimes thicker, sometimes thinner, thus producing the impression that they have a zig-zag curve. This depends essentially on an intermittent illumination of the retina by parallel bordered striæ. The same phenomena could be observed by the left eye of the patient without difficulty, though they were always more readily produced and much more distinct in the right eye. Both eyes were then examined for astigmatism. Left S. was $\frac{20}{20}$, though vision was much more distinct with cyl. $-\frac{1}{48}$ axis horizontal. Right S. was only $\frac{20}{50}$ without a glass, and, remarkably, no improvement could be obtained by spherical glasses. The examination showed in the horizontal meridian emmetropia, and in the vertical, hypermetropia $\frac{1}{48}$, and with cyl. $+\frac{1}{48}$ improvement of the vision to $\frac{20}{20}$. Atropine produced no change in this strange condition, and the wide pupil presented an opportunity for a minute examination with the ophthalmoscope. The lens was absolutely clear, and in the fundus of the eye only a strong injection of the retinal vessels could be seen in the region of the macula. Professor Becker was unable to convince himself of the presence of a suspected difference in the plane at this point. The optic nerve presented no change.

April 1st, the patient returned, in consequence of several defective shots in hunting. Left eye unchanged; right, only Sn. 70 recognized without a glass, cyl. $+\frac{1}{48}$ improved S. only to $\frac{20}{40}$. Neither scotoma nor metamorphopsia were present. The facility with which zig-zag lines had appeared had now disappeared and, as the patient experienced no pain, there were no subjective symptoms. The ophthalmoscopic appearances had changed only to the extent that the optic nerve appeared reddened in comparison with that of the left eye.

November 1st, 1870, the patient stated that during the summer the eye had slowly but steadily grown worse; he also had a feeling as though the matter was very serious. Now, without a glass Sn. 200 was not recognized; with $+\frac{1}{30}$ S. was $\frac{20}{70}$. The eye which was before emmetropic had now become hypermetropic. Examined with the ophthalmoscope, the refractive media were completely clear, the contours of the optic nerve were confused towards the macula lutea, the retina at the same place grayish blue, and permeated by abnormally wide vessels. Exactly at the macula lutea there was a grayish-red nodule, projecting towards the vitreous, of four times the area of the

optic nerve, around which the retina presented a condition similar to that observed at the nerve. In consequence of the thorough clearness of the vitreous, it was easy to perceive, especially at the centre of the elevation, numerous pathological new-formed vessels. The diagnosis of a subretinal tumor was without a doubt.

There was, at the same time, a slight defect in the field of vision, which projected downwards and outwards from the point of fixation, but was not spontaneously noticed by the patient. He could still read, with difficulty, Jaeger Nos. 7 and 8, in doing which, it was noticed that the eye turned somewhat downwards and inwards.

Repeated examinations with the pupil dilated having shown that the tumor was growing, the diagnosis and prognosis of the disease were imparted to the patient and enucleation proposed. He consulted two other ophthalmologists who were not opposed to this proposition, and he therefore acquiesced.

An increase of the hypermetropia to $\frac{1}{20}$ with S. $\frac{20}{50}$ having been found November 25th, and a further increase to $\frac{1}{18}$ with S. $\frac{20}{70}$ just before the operation, Professor Becker enucleated the eye December 5th, 1870, in the presence of Dr. W. Hess, of Mayence.

Six and a half years have since passed with no relapse. The patient, who is very solicitous with regard to the other eye, wears an artificial eye temporarily, but prefers a bandage for ordinary use. The left eye is perfect, and the occasional complaining of the patient may be ascribed to the simple fact that he has but one eye, and that the presbyopia is, of course, increasing.

The examination, made by Dr. George R. Cutter, of New York, shows:

Macroscopic.—Eye normal, except that in the macular region there is a slightly pigmented tumor of the choroid, about the size of a millet-grain, which has coalesced with the sclera and retina. The retina is elevated for a short distance around it; elsewhere it is in apposition with the choroid.

Microscopically the tumor consists predominantly of uncolored spindle-cells, of medium size, with scanty intermediate substance and moderate vascularity. The pigment it contains is evidently due to the degenerated pigment-cells. In the periphery of the tumor round cells are also met with,

though not very abundant. The transition into the uninfected choroid is very steep, more precipitately outwards than towards the optic nerve. Externally, the limits of the tumor form a completely circular line, which lies within the layer of the coarser vessels; so that the tumor is covered inwards by the chorio-capillaris, lamina elastica choroideæ, and pigment epithelium, while externally, from it the so-called lamina fusca may still be followed for a short distance. This foliation of the choroid is quite sudden, and directly outwards from the tumor the former is entirely normal, with the exception of a slight infiltration of the chorio-capillaris with migratory cells. The inner limitation of the tumor is not quite so precipitous, for a more tongue-shaped process extends between the chorio-capillaris and the lamina fusca. The remaining conditions are the same. The greater portion of the pigment is at the periphery of the tumor, but within the latter and some distance from its external margin. It is apparently due to the great proliferation of the stroma-cells, and forms, in part, large lumps of pigment, in which the constituents of a cell are unrecognizable, while in the most peripherical portions of the tumor only the rather unchanged pigmented stellate cells appear to be present.

As has already been said, the lamina fusca may be recognized as a distinct layer throughout the periphery of the tumor. Only in the central portion of the latter the sclerotic has coalesced with the tumor. Here the sclerotic is somewhat bulged; its inner lamellæ are somewhat exfoliated and permeated with tumor elements. There is otherwise only superficial pigmentation of the innermost layers of the sclerotic and of the sheaths of the vessels in the vicinity of the tumor. Nevertheless, the pigment is not contained within the cells of the tumor, but lies either free in the tissue or within its normal cells.

At several places the tumor sends out processes along the vessels, as a result of the configuration of the choroidal tissue. In peripheral sections they sometimes produce the impression of isolated nodules, while at others the uninterrupted con-

nection with the main tumor may be recognized. As the sections do not always contain a lumen of a vessel, one might believe that the tumor-elements were contained within the vessel; the transverse section of a compressed vessel may usually be found, however, at the periphery of the apparent nodule.

The choroid, in contrast to places removed from the tumor, is thickened, especially between the tumor and the optic nerve. This depends, however, only on the dilatation of the vessels and loosening of the tissue from tension and exuded fluid (œdema), without a trace of tumor-elements.

The pigment epithelium is throughout normal and well preserved; only so far as the retina was detached the pigment-cells are proliferating and form large pigmented lumps, in which nuclei are but rarely recognizable. This proliferation of the pigment epithelium also occurs on the tumor. At the apex of the latter the lamina elastica and the proliferated pigment-epithelium (the chlorio-capillaris has already been taken up by the tumor) terminate with sharp borders. The tumor has here perforated the inner choroidal layers and proliferated inwards in a raspberry form. Throughout the extent of this portion the retina has also coalesced with the tumor itself; while in the remaining area of the tumor it is separated from the pigment epithelium by a stratum of fluid.

Of the remaining pathological changes in the eye—the anterior section has not yet been examined; the vitreous contains a moderate number of cells—only those of the retina are to be mentioned. Removed from the tumor and so far as it had not suffered detachment, the retina was so firmly adhered to the pigment epithelium that, in the separation caused by the preparation, the pigment epithelium remained attached to the retina. The rod-and-cone layer was completely intact, and no essential changes were found in the other layers, only that folds had formed in the retina in many places. These folds were produced by the sinking of the limitans externa, with the bacillar layer deep into the external granular layer. The intergranular and inner granular layers are also somewhat thinned at these places, and are somewhat displaced in an

outward direction; while the inner layers of the retina pass over unchanged. The deepest point of the depression frequently corresponds to the transverse section of a vessel. The spaces formed between the rods and the pigment epithelium by the folds are filled with granular pigment. The formation of folds increases towards the tumor, and just at the border of the retinal detachment there is usually a very pronounced detachment.

The retina is, in toto, somewhat thickened, which is due to increased serous infiltration. This is also the case where special cavities have not yet been formed.

The detachment of the retina in an inward direction does not extend quite to the optic nerve, and in its district the retina presents pronounced changes, which are chiefly to be regarded as a hypertrophy of the connective-tissue intermediate substance, with more or less destruction of the nervous elements. The retina assumes towards the tumor more and more the appearance of a sponge-like network, in which the several layers may still be recognized, but they no longer contain their normal cellular constitutents. These changes are most widely diffused in the nerve-fibre and ganglionic layers, and may be followed as far as the papilla, though just here they extend relatively less deeply, and even at the periphery of the place of coalescence the ganglion-cells are still partially intact. The outer layers lose their normal contents more and more towards the tumor, and form a spongy tissue, probably filled with fluid, in consequence of which some layers, especially the intergranular layer, increase considerably in volume. The bacillar layer presents, in the extent of the retinal detachment, the familiar changes known as the cadaveric appearance, though they must have here occurred *intra vitam*, as the eye was placed in Müller's fluid immediately after enucleation. The limitans interna is considerably thickened throughout the whole retina, but especially in the vicinity of the tumor.

At the place where the tumor coalesces with the retina, only the thickened limitans interna can be recognized as a distinct

layer. The remaining attenuated retina forms a spongy tissue without nervous elements; the nerve-fibre layer, ganglion cells, and, perhaps, also the molecular layer are still present as such up to just at the place of coalescence, while the external layers of the retina have still earlier ceased to be recognizable as distinct layers. The true intergrowths are only filamentous or cord-like, and are connected with the depressions of the nodular tumor. The degenerated retina is compressed between them by the growing tumor. The tissue of the intergrowths consists of wavy connective tissue with isolated spindle and round cells, and is throughout readily distinguishable from the tumor. In no place does the retina present pigmentations, and tumor-elements can nowhere be discovered in it. (Compare also in the atlas of Pagenstecher and Genth, plate XV., fig. 7, and plate XXVI., fig. 8).

2 (244). Sister Ph., from the maternity at Niederbronn in Alsace, came October 21st, 1869, to the Heildelberg clinic. For the history of the case see Becker (Archiv für Augen- und Ohrenheilkunde, Bd. I., 2, page 221), in which may also be found a figure of the eye, cut through the equator, of double the natural size. The essential symptom was a central scotoma. The retina was attached, and the diagnosis of a subretinal tumor, rendered certain by the discovery of newly-formed vessels in a prominence of the macula lutea, was substantiated by the enucleation performed soon afterwards by Professor Becker. Glaucomatus appearances were not yet manifested. The patient still lives, and seven and a half years have since passed.

The examination, made by Dr. G. R. Cutter, of New York, showed:

Macroscopic.—The eye normal, with the exception of a tumor of the choroid situated in the region of the macula, to which the retina was applied and with which it was centrally coalesced. In addition to the main tumor, there was also, externally to this, at the equator, a second smaller node in the choroid, over which the retina likewise passed without any elevation, and which had escaped discovery at the ophthalmoscopic examination.

Microscopically, the almost unpigmented tumor consists of tolerably large round cells, with large nuclei which are angular in places or furnished with quite short processes, in a scanty basis substance. They are throughout free from pigment, and all the pigment present is to be traced to degenerated stroma cells. The peripheral portion of the outer surface of the tumor is inclosed by the lamina fusca, and only in the centre is there any cohesion with the sclera; here, the inner layers of the sclerotic deviate from each other, and the spaces thus formed are filled with cells. In the region of the tumor, pigment may also be found as far as the midst of the sclera, in the interstices of the lamellæ, though without its being contained in the cellular elements. At one place, nearly exactly at the middle point of the tumor, a tolerably thick cone of sarcoma cells passes from the latter into the sclera, in an outward direction, not quite to the middle of the sclerotic. According to the arrangement of the scleral tissue, this place corresponds to the passage of a vessel, though nothing of the latter can be perceived.

The tumor is sharply demarcated towards the choroid. The latter, in the vicinity of the sarcoma, presents immense expansion of the vessels and separation of the choroidal tissue, apparently from fluid (œdema), though no tumor elements can be found here. The widely gaping lumina of the choroidal vessels, or those still filled with blood, suddenly terminate at the transition to the tumor in the microscopic sections, though it may often be seen that the tumor nodules, which are met with in the sections at the place of the lumina of the vessels, do not lie within the vessels, but rather have crowded the latter to one side or the other. In peripheral sections, there is often produced, in this way, an appearance of isolated nodules, though, in reality, a tongue-shaped process extends from the tumor along a vessel, similar to that of the preecding case (1).

The tumor, which crowds the lamina fusca from the choriocapillaris at the border of the choroid, appears, as in Case 1, to extend principally within the layer of the coarser vessels. The chorio-capillaris, accordingly, may be followed far over the tumor, and presents infiltration with round cells which, how-

ever, are smaller than the true round cells. The lamina elastica may be followed over the entire tumor, and is nowhere perforated. The pigment epithelium lying on it, in the more peripheral portions of the tumor, is proliferating; that of the remainder of the fundus is intact. More towards the centre of the tumor, only the remains of pigment-cells are to be found, imbedded in a more or less thick stratum of concentric fibrous connective tissue, with a few other cells. In places, especially in the middle point of the tumor, there is no further trace of pigment present within the striated connective-tissue mass; the pigment epithelium is therefore entirely destroyed. The retina, as far as the tumor and also for a short distance over it, appears entirely normal in all its layers; in the centre it has coalesced with the connective tissue on the lamina elastica choroideæ. The first change is presented in the intergranular layer. This is very distinctly striated, and makes an impression as though the retinal layers external to it were strongly extended beneath the inner ones. The thickness of the retina remains normal over the entire place of coalescence, with the exception of the cones and rods. The outer members of the latter constantly increase towards the place of coalescence three or four fold, while the inner members may still be recognized of normal length for a short distance, though further on they are no longer distinguishable.

The true intergrowths are only filamentous, and they form between the connective tissue on the choroid and the membrana limitans externa, numerous spaces which are filled by the elongated rods. An impression is made as though between the elongated rods a granular exudation (probably produced by the hardening method) had been deposited. The elongated rods are demonstrably in direct connection with the limitans externa and the newly-formed connective tissue on the inner side of the choroid, though, in tearing off during the preparation, they wholly separate from the limitans externa. In places, especially towards the centre of the coalescence, elongated rods pass over into a lacunar tissue which nowhere, however, contains cellular elements, and this spongy tissue

occasionally incloses connected pieces of the elongated rod-layer. It appears as though this lacunar tissue were to be regarded as coagulated exudation, which had probably occurred during life.

The retina itself appears changed only at the places of the true, filamentous intergrowths. Here, for a very short distance, only the ganglion cells, and optic-nerve fibres, are preserved, though even the former are occasionally wanting. The remaining layers are here entirely without the nervous elements, are considerably stretched out in the direction of the intergrowth, and permeated by numerous small lacunæ. Some of these intergrowths are manifestly freshly torn, which may possibly have happened during life.

The node in the equator presents the same histological structure as the main tumor. It is but slightly adherent to the sclerotic, and besides, the supra-choroid is covered internally by the chorio-capillaris, lamina elastica choroideæ, and almost unchanged pigment epithelium. The completely intact retina is closely applied to the tumor and is nowhere elevated. No direct connection between the two tumors is to be discovered.

The optic nerve is normal. The anterior half of the bulb has not yet been examined.

3 (164). Commercial clerk L. R., 28 years old. For the anamnesis see Becker, l.c., page 224. For the ophthalmoscopic examination, see these ARCHIVES, Vol. I., 2, plates A and B. Enucleation ten months after the appearance of the first subjective symptoms (vibrations before the eye), and eight days after the occurrence of the first glaucomatous symptoms, December 1st, 1867. The patient is still, more than nine years since the operation, entirely well.

Macroscopic Examination.—The anterior section of the bulb presents nothing special beyond the peripheral coalescence of the iris with the cornea. The diameters are also within the normal bounds.

In the posterior section, nearly in the midst of the upper outer wall of the eyeball, there is a yellowish, somewhat uneven, tolerably hard tumor, the size of a hazelnut, which

rises almost at a right angle from the adjacent choroid. It reaches neither to the superimposed wall of the bulb, the posterior surface of the lens, nor the optic nerve. The retina is separated for a distance around the base of the tumor, everywhere else it is adherent. The tumor has coalesced with the retina at its middle point. Nothing abnormal can be recognized in the remaining portions of the eye.

Microscopic Examination (Dr. Chodin).*—The tumor is a vascular, white, small-celled spindle-cell sarcoma. The cells contain a relatively large nucleus, with a distinct nucleolus, and lie in a very scanty matrix, with numerous thin-walled vessels; towards the periphery of the tumor round and ramified cells also occur, though in small numbers. Pigment-cells are present only at the border, towards the choroid and sclerotic, and likewise belong to the matrix. The true tumor-cells contain no pigment.

Centrally the tumor has coalesced with the sclerotic, but only the innermost layers are pressed apart and filled with the tumor substance. No actual perforation can be found; the tumor is also located at a portion of the sclerotic which is not perforated by either vessels or nerves.

The transition of the tumor into the choroid is quite sudden; in its vicinity are found dilated blood-vessels, and for a short distance, profuse infiltration with round cells.

In this case, also, the tumor proliferates essentially into the middle strata of the choroid, and the former is for some distance distinctly covered by the chorio-capillaris, lamina elastica, and degenerated pigment epithelium. Remains of the pigment epithelium may be recognized nearly throughout on the surface of the tumor. The former is found partly in strong proliferation, especially towards the place of coalescence with the retina, at which place it is most marked, partly in manifest degeneration at the periphery of the tumor, and further on from the periphery, it gradually resumes its normal condition.

* The examination of this and the following eyes was made by Dr. Chodin, with the exception of Nos. 10, 11 and 16, which were examined by Dr. Knies.

The lamina elastica is still to be seen throughout, and at the point of coalescence with the retina, which is here surface-wise, and not merely through isolated filaments, is strongly thickened by superimposed, meridional, striated connective tissue, with remains of proliferous pigment epithelium. This coalescent mass forms a regular capsule towards the tumor, but is perforated by the latter at the centre.

The partially-detached retina is completely normal till almost at the place of intergrowth. The pigment epithelium and partly also the rod-layer remain on the choroid at the place of detachment. At the place of intergrowth commences a sudden thickening of the retina to more than threefold, caused by the hypertrophy of the supporting apparatus, with numerous laminæ filled with fluid. Within the proliferated glia, towards the margin of the coalescence, a few groups and aggregations of granules of both granular layers are seen imbedded. The external portion of the retina, the granular layers, and the intergranular layer participate chiefly in this thickening, which permits only of the recognition of the nerve-fibre layer and the limitans interna as distinct layers, while the rods and cones have been destroyed without leaving a trace. This condition is presented on observing the transition into the normal portions of the retina. At the place of intergrowth, the retina is infiltrated moderately with round cells, and strongly with pigment, which latter has evidently penetrated from the proliferated pigment epithelium, and may still be found a considerable distance off in the retina. At the place of coalescence itself, the outer boundary of the retina is formed by the already-described new-formed tissue on the lamina elastica choroideæ, which is penetrated only at one place by the tumor substance. The proliferous retina has here been penetrated, and the continued profuse proliferation is evidently promoted by the distended tissue-clefts of the œdematous retina. The infection with sarcoma cells extends only about half the thickness of the retina. There is no actual perforation of the retina, and there has been no lateral extension further than about 0.5 mm. from the place of penetration. We are,

therefore, justified in assuming that the proliferation into the retina was of very recent occurrence.

The condition characteristic of glaucoma (adhesion of the periphery of the iris with the cornea) is present, although still very fresh. The corpus ciliare, subconjunctival tissue, and the whole corneo-scleral margin are profusely infiltrated with migratory cells.

The optic nerve presents no excavation as yet, though there is great infiltration of the papilla with round cells (compare on this, Knies, Archiv für Ophthalmologie, Bd. XXI., Theil 3, page 167, Fall V.), a stage which appears to precede that of excavation.

4 (40). The eye was enucleated November 13th, 1866, on account of stadium glaucomatosum, and an irido-choroiditis of the other eye which had existed for some time. The diagnosis was for a long time doubtful, as the media were early cloudy. An iridectomy had been tried, though without result. After the enucleation, an almost globular, round sarcoma of the choroid with a short pedicle was seen. The enucleation exerted no influence on the course of the disease in the other eye, so that the question whether it was also attacked with sarcoma or was sympathetically affected could not be determined, the less so, as the patient withdrew from observation because the eye became no better. Sympathetic affection of the other eye was considered more probable, however, as of more frequent occurrence.

Macroscopically.—Length of the bulb, 23 mm., by 21 mm. wide ; cornea somewhat thickened, the lens almost in contact with its posterior wall; the iris and corpus ciliare are indistinctly demarcated. External to the papilla, extending almost to the equator, there is a brown tumor, darker at its periphery, 10 mm. long, 12 mm. wide, which projects into the middle of the vitreous cavity, where it is in contact with the funnel-shaped detached retina. The tumor arises very steeply from the apparently somewhat thickened choroid, and has a smooth surface.

Microscopic (Dr. Chodin).—The tumor consists, for the greater part, of unpigmented, but in part also of pigmented

cells of rounded and spindle-shaped form, in a not very plentiful structureless intermediate substance, with a great quantity of blood-vessels. The transition into the choroid is sudden, and presents quite similar details to Case 3. The adjacent choroid, especially between the tumor and the optic nerve, has widely gaping blood-vessels, and is œdematous; but appears entirely free from tumor-cells, and only in the chorio-capillaris is there a moderate number of emigrated white blood-corpuscles, which increase in numbers considerably towards the tumor. In consequence of the regular arrangement of the sarcoma cells, the limits of the tumor are quite sharp, and the choroid is pressed apart into two layers, as in the previously described tumors. The tumor is very loosely connected with the sclera; but in the centre the sarcoma-cells crowd between the lamellæ of the latter, while elsewhere the suprachoroid forms the external boundary of the tumor. The inner boundary is formed for a distance by the chorio-capillaris, but throughout by the lamina elastica and altered pigment epithelium. Rows of tumor-cells pass from the place of intergrowth with the sclera for a considerable distance, especially towards the optic nerve. The vessels of the sclera in the vicinity also show pigmentation; an actual perforation or extrabulbar portions of tumor are, however, nowhere to be discovered.

The optic nerve presents a glaucomatous excavation filled with an amorphous, granular mass; it is entirely free from tumor-elements, and but moderately infiltrated with cells.

There is total detachment of the retina. The retina, up to the already mentioned place of coalescence, is relatively but slightly altered. At this place it is strongly thickened, and presents changes quite similar to those of the preceding case, but is tolerably plentifully infiltrated with round cells. There is, besides, presented the already described hypertrophy of the connective-tissue supporting apparatus, as we are in all probability to interpret the changes in question. The cones and rods are destroyed at the place of coalescence.

In regard to the anterior section of the bulb, the corpus ciliare presents the signs of a pronounced cyclitis, strong, pur-

ulent infiltration of the tissue, proliferous and degenerative growth of the pigment, and purulent exudation in the anterior section of the vitreous and in the canal of Petit, with many red blood-corpuscles. The space of Fontana presents the adhesion of the periphery of the iris to the cornea by new-formed tissue characteristic of glaucoma. The iris is itself tolerably atrophic, and a portion of the stump has healed into the pigmented iridectomy cicatrix. The pigment extends from the corneal cicatrix tolerably far into the sclera, and also extends around the canal of Schlemm.

The remaining portions of the eye present nothing worthy of remark.

(11). Right eye of a man about 50 years of age, enucleated by Dr. Hirschberg, October 11th, 1874.

Left eye normal, hypermetropic.

Right eye, blind more than a half a year, has recently been painful. Deep, cloudy ciliary injection, some conjunctival veins especially strongly filled. Cornea, clear; anterior chamber, narrow; pupil, wide and fixed; lens, greenish and completely cloudy; bulb, enlarged in the equator, as well as in its posterior portions. Clinical diagnosis: initium degenerationis glaucomatosæ; it could not be decided whether there was glaucoma simplex or tumor intraocularis.

Macroscopic.—Axis of the eye, 22.5 mm.; transverse diameter, 24 mm. The whole eye is filled with exudation coagulated by Müller's fluid. On the inner wall of the bulb there is an irregular pigmented tumor, which fills the entire inner half of the cavity of the eye, from the corpus ciliare and lens almost to the papilla. The retina is elevated in a columnar form, and at the anterior half of the bulb has coalesced with the tumor; nothing more is to be seen of the retina between the lens and the tumor.

Microscopic (Dr. Chodin).—The tumor consists of predominantly unpigmented cells in a tolerably abundant amorphous or fine-fibrillated basis substance, with many blood-vessels. Nearly every cell has its own space in the intermediate substance. The majority of them are round or but slighty elon-

gated. They are but rarely of a pronounced spindle shape. The pigmented tumor-cells present the same variegated forms as the unpigmented, and are scattered in an irregular manner between the latter, most plentifully in the peripheral portions of the tumor.

The tumor projects almost at a right angle from the somewhat atrophic choroid, which, except immediately at the tumor, is completely normal. The choroid is here split by the tumor into an inner and outer lamina, which, as in the cases already described, pass over the inner and outer surfaces of the tumor. In the peripheral portions of the tumor, there is great wealth of pigment, and evidently strong proliferation of the pigmented stroma cells. The anterior still normal portion of the ciliary process is also quite sharply demarcated from the tumor. The ciliary muscle is free from sarcomatous elements.

In the middle the tumor has perforated the lamina elastica choroideæ and the retina, and proliferates freely in the remains of the vitreous space. The retina appears somewhat atrophic; the cones and rods are everywhere wanting. Instead of them, one finds in those places where the structure of the retina is still maintained, and is applied to the tumor, numerous long filamentous processes between the limitans externa and the lamina elastica choroideæ; often so numerous that a regular hatching is present. The limitans interna is strongly thickened by numerous concentric layers. The pigment epithelium adheres to the choroid, and is strongly proliferous in the region of the tumor. At the place where the tumor perforates the retina, only indistinct remains of the latter are still to be recognized.

The optic nerve and the sclera, with the exception of the innermost layers over the tumor, present nothing special; but in the vicinity of the tumor and towards the papilla, between the fibres of the sclera and around the vessels, pigment is seen either free or in stellate cells. This may often be followed as far as the outer strata of the sclera.

The entire space within the eye is filled with coagulated exudation, which contains numerous globular concretions

which are frequently in recognizable connection with the pigment epithelium. Very often one sees a globular drop, half of which still extends within a pigment cell, or only projecting into it by a pedicle, which reminds one of certain appearances of the epithelium of the intestinal canal. A further proof that the concretions are in connection with the pigment is presented by the circumstance that, where, by the preparation, the exudation is separated from the choroid, the pigment always adhered to the former. We shall return to this point further below.

For the changes characteristic of glaucoma see Graefe's Archiv, Bd. xxiii., Abth. 2, page 62, No. 16, where this case has already been briefly communicated.

6 (26). Anamnesis wanting.

Macroscopic.—The bulb is almost globular (25 mm. broad, 24.5 mm. long), the depression between the cornea and sclera is obliterated. In the posterior section of the bulb, somewhat above the macular region, there is a pedicled flat tumor the size of a hazelnut. It is covered over its whole extent by the retina, which is detached for but a short distance around the base of the tumor. The tumor is in the middle of a yellowish color, pigmented in the peripheral portions, especially at the transition into the choroid, which is dyed almost black. In the same meridian as the tumor, immediately behind the ciliary processes, there is a black nodule, 2 mm. long, 1 mm. broad. The optic nerve is excavated, somewhat thinned and distinctly pigmented.

Microscopic.—The tumor consists predominantly of unpigmented spindle-cells. These lie in a hyaloid intermediate substance and are rather small, with a large nucleus and sharply marked nucleolus. They are fasciculated and arranged in short strips, which in the transverse section often makes the impression of an alveolar structure. Between these uncolored cells lie irregularly scattered larger pigmented, mostly reticular or spindle-shaped cells and irregular lumps of pigment of a

doubtful cell nature. They are with great probability to be regarded as derivata of the stroma-cells.

The transition of the tumor into the unchanged choroid is quite gradual. The latter, towards the tumor behind, especially between the optic nerve and the latter, becomes constantly richer in cells, from infiltration with round cells which differ in no wise from emigrated white blood-corpuscles, and gradually become intermingled with spindle cells. The relations are furthermore strongly concealed by the great pigmentation of the transition portion.

The tumor has firmly coalesced with the sclera, the innermost layers of which present infiltration with sarcoma cells. There is, besides, extensive pigmentation with granular pigment, especially around the vessels, whereby the coloring matter is also contained within cells. This pigmentation may be followed along one of the ciliary nerves, which passes directly at the base of the tumor, as far as the exterior. Pigmented spindle-cells may likewise be followed to the exterior along one of the posterior ciliary arteries. The inner surface of the gradually thickening choroid is covered by the chorio-capillaris strongly infiltrated with round cells, the lamina elastica, and proliferating pigment epithelium. The former ceases at the true tumor, which arches over fungus-like. The two inner layers may still be recognized for a distance over the tumor. The latter arches over so strongly that the remains of the inner choroidal layers are in direct opposition with each other for a distance.

The optic nerve presents a glaucomatous excavation which is filled with a pigmented tumor mass. The pigmentation and immigration of sarcoma-cells extend outwards from here, especially along the central vessels, though the cut end of the optic nerve appears free from pigment. The pigment is partly free, partly inclosed in cells. Free pigment is also found in the intervaginal space, especially at the side of the tumor.

The retina has undergone connective-tissue degeneration and is in places pigmented ; no place of coalescence with the tumor was found.

The completely isolated black nodule behind the ciliary pro-

cesses lies between the lamina elastica choroideæ and pars cilaris retinæ. It is covered externally by completely normal choroid, and consists entirely of large, very strongly pigmented, rounded lumps of protoplasm without a trace of sarcomatous elements; it is, therefore, a true melanoma nodule. The retina is irregularly pigmented at the place in question. The principal points found in the anterior section of the bulb were: cornea normal, with the exception of numerous migratory cells in the lowermost layer of the anterior epithelium; the iris and corpus ciliare are infiltrated with cells, the former firmly coherent at its periphery to the cornea by new-formed pigmented tissue. The insertion of the iris is considerably crowded into the corneo-scleral border. There is also pigment in the canal of Schlemm and in its vicinity, and continues from here backwards into the sclera, corresponding exactly to the blue coloration of Fig. 1 in Virchow's Archiv, Bd. lxv., Tafel xx. In all these places the pigment is granular and not inclosed in cells, with the exception of the tissue of the intergrowth between the iris and cornea, where it is contained in cells. Behind the canal of Petit and the lens, there is a striated tissue with pigment and numerous red blood-corpuscles.

7 (5). C. F., about 50 years old. The tumor was observed for a long time as a rounded detachment of the retina with an unusual arrangement of the vessels behind it (compare Becker, Knapp's Archiv, Bd. i., 2, page 224, No. 5), without the patient having any trouble besides disturbance of vision. In April, 1868, he returned with a greatly enlarged glaucomatous bulb, which was then enucleated. The tumor had proliferated backwards and into the optic nerve (?). After a few months there was a relapse in the orbit; but patient declined the operation. Nothing further of the result is known.

Macroscopic.—The bulb is considerably enlarged, longitudinal diameter 30 mm., transverse diameter 27 mm. Anterior chamber obliterated, the iris and lens are directly applied to the cornea. In the posterior section of the cavity of the eye there is a yellowish brown, unevenly pigmented mass, which extends inwards to the corpus ciliare, externally to the equator. In

this mass is noticed a bright line which passes from the papilla nervi optici forwards and outwards, and thus divides the whole tumor into an inner larger, and outer smaller half. The free space before the tumor is filled with a soft yellowish mass. The sclera appears normal, but external to the optic nerve, in the region of the macula, it is somewhat thinned and here there rests on it, outwards, a second tumor, 13 mm. broad and 9 mm. thick. The head of the optic nerve is colored somewhat darker, further outwards its color becomes normal.

Microscopically (Dr. Chodin) the tumor presents the character of a strongly pigmented, round-celled sarcoma, with tolerably large cells. The unpigmented cells are somewhat smaller, and mostly lie in a coarse net-work, which is formed of columns of pigmented cells, and correspond to coarser vessels. The transition of the choroid into the tumor takes place by a gradual thickening of the former, which is caused by dilatation of the vessels and infiltration with ordinary round cells and larger tumor-cells; then the lamina elastica and the pigment epithelium (which, when present, is throughout in contact with the choroid) cease suddenly, and the tumor proliferates fungus-like into the bulbar space.

The sclera is pigmented; its innermost lamellæ are crowded apart by tumor elements. An actual perforation by the sarcoma-cells is presented only in the macular region, however, along one of the posterior ciliary arteries, where the extra-bulbar tumor nodule rests. From this place of perforation, the tumor-cells crowd in all directions in between the lamellæ of the sclera, so that a regular tumor nodule exists within the latter. The retina is detached in a columnar form, and is, for the most part, absorbed by the tumor. It is much more readily recognizable macroscopically than microscopically, as it contains little pigment. The glaucomatous excavation is filled with tumor substance, and from here there is a penetration of pigmented and unpigmented sarcoma-cells along the loose connective tissue around the central vessel, and from there also into the tissue between the nerve-fibres, the most extensively outwards along the vessel. The sheath space is free up to the

part external to the optic nerve; where the extra-bulbar tumor reaches here, it contains undoubted tumor-cells.

Anteriorly the tumor extends on the inner side of the eye as far as the ciliary body. Where it does not reach so far, there is presented only the atrophic ciliary body and iris synechia characteristic of glaucoma; corresponding to the former, on the contrary, widely reaching changes are seen. From the ciliary body the ciliary processes have been essentially absorbed by the new-formation, and proliferate into the corneo-scleral margin, the latter tilted out in a purse-like form. The membrane of Descemet is here perforated half a millimetre from the peripheral end, the ends turned over inwards and considerably pressed apart for a millimetre by tumor substance. The true muscular portion of the ciliary body is recognizable in the transverse section as a lens-shaped white place, completely transformed into tumor, but considerably pressed backwards half a centimetre by the much more strongly proliferating portions of the iris and ciliary processes. Corresponding to the perforation of Descemet's membrane, the entire corneo-scleral margin is permeated by sarcoma cells, and striæ of these pass forward from here into the cornea, backwards into the sclera, and externally into the subconjunctinal tissue. Otherwise the cornea, especially beneath Bowman's membrane, is merely infiltrated with ordinary (much smaller) migratory cells, which are also plentiful in the deeper strata of the anterior epithelium.

The canal of Petit is filled with tumor elements. In the lens, beneath the anterior capsule, granular pigment is formed between and under the cells of the anterior epithelium.

The extrabulbar tumor at the posterior pole, which, as has already been mentioned, is in continuous connection with the intrabulbar, presents the same structure as the latter, but is less richly pigmented.

8 (91). Th. B. had a lower flap extraction of the right eye, October 17th, 1863, at Arlt's clinic. There was a slight secondary cataract, reads Jæger No. 9 with $+\frac{1}{2}$. He returned June 11th, 1866, on

account of vision having become worse within two months. A globular retinal detachment projects from above outwards into the pupillary region. Professor Arlt attempted to puncture the retina through the sclera. A rent can be seen with the mirror in the detached retina; the detachment had increased below and outwards, however. September 29th, 1866, a broad iridectomy was made upwards on account of pain and increased pressure. The pains at night continued. February 7th. 1867, the eye, which protruded somewhat, was enucleated. October 10th, 1867, it became necessary to clean out the orbit in consequense of a relapse, but death occurred the following day from cerebral apoplexy; cf. Becker, l. c., page 223.

Macroscopic.—Nothing special in the form and size of the anterior section of the bulb; the posterior is almost entirely filled with a yellowish tumor substance, homogeneous in color, which extends outwards almost to the posterior surface of the lens, inwards only to the equator. From without inwards, from the posterior portion of the ciliary body and the choroid, there is a loose, almost black mass, 13 mm. long and 5 mm. broad, of an elongated oval form. The free space anterior to the tumor contains a yellowish mass with portions of the detached retina.

Microscopic (Dr. Chodin).—The tumor, which is pigmented almost solely in its periphery, presents a pronounced alveolar structure. The colorless cells have various forms and an epithelial-like habitus; they are tolerably large, with a large nucleus (also with two) and nucleoli; they are frequently connected by processes with the stroma. In the true tumor, the pigment is found only in the stroma-tissue. The tumor is, accordingly, to be regarded as an alveolar sarcoma, and is very vascular. The pigment at the periphery is contained in part in large rounded lumps of protoplasma, partly in stellate cells. The loose black mass at the ciliary body consists essentially of large pigmented lumps of protoplasm of irregular form and quite irregular aggregations of pigment. Fibrillated tissue and smaller white cells are found between them in very small numbers. The transition into the tumor is quite gradual. The analogy with the melanoma nodule in case 6 is, therefore, striking.

Immediately adjacent to the tumor, the choroid is either entirely normal or only more or less inflamed, without a trace of tumor elements. The chorio-capillaris, lamina elastica, and the altered pigment epithelium may still be followed far over the tumor.

Only the innermost strata of the sclera contain tumor-cells; further on, there is only pigmentation, especially around the vessels. No actual perforation was found, for the optic nerve was cut out and not further examined.

The retina is totally detached; the pigment epithelium remained adherent to the choroid.

Anteriorly, the eye shows glaucomatous adhesion of the iris. The tumor has penetrated into the ciliary body, from there into the corneo-scleral margin and the cornea itself; that is, between the membrane of Descemet and the corneal tissue. There is pannus of the cornea; the cicatrix of the iridectomy is strongly pigmented, as is also a large ciliary vessel at a place tolerably widely removed from the tumor.

The relapse in the orbit is an uneven lobular mass of the same structure as the original tumor, only much richer in pigment; the true sarcoma-cells here also contain pigment.

9 (39). The history of the case has already been published by Becker, l. c.

Fig. 1.

The adjacent figure (1) represents a horizontal section of the globe. There is sarcoma of the macular region, projecting very slightly into the

bulb, with a large extrabulbar tumor and infection of the optic nerve. (A quite similar case is described by Nettleship, Ophth. Hosp. Reports, vii., p. 611, in which the patient was still well five years later [ix., p. 40, No. 3]; though here the optic nerve was free.)

Microscopic.—The intraocular almost black tumor presents the character of a spindle-celled sarcoma, with few white and many pigmented cells within a very scanty, likewise pigmented intermediate substance with few blood-vessels. The transition into normal choroid is tolerably gradual, though the margins of the tumor, which stretches in a tongue shape between the suprachoroid and chorio-capillaris, may constantly be recognized. So far as the pigment epithelium lies on the tumor, it is in strong proliferation, and constitutes, with a new-formed striated tissue, a special, more or less thick layer on the tumor. The retina, which is throughout attached, is totally degenerated over the tumor, and a considerable distance outwards is pigmented, and contains numerous pigmented sarcoma-cells. It has coalesced with the tumor at its centre, and there presents the already-described œdematous network. It is here also perforated by the tumor, and the cells of the new-formation are found far into the laminæ of the degenerated retina. While the outer half of the retina is thus transformed into a thin connective-tissue membrane, permeated with numerous pigment-cells and free pigment, and which has cohered to the choroid, on the inner half a trace of structure may still be recognized to the extent of an external reticular and an internal fibrillated layer, together with the limitans interna.

Here, also, the retina is pigmented. The pigment consists of granules in the connective-tissue cells of the degenerated retina, or in the large round cells, while distant tumor-cells are wanting. There is also pigment in the retina in places where the choroid and pigment epithelium are quite normal.

The optic nerve presents a glaucomatous excavation filled with sarcoma substance, and, together with the adjacent portions of the retina, is completely transformed into sarcoma-tissue. Tumor-cells are also found in its sheath, and outwards,

about in the macular region, the sclera, which is elsewhere only superficially infiltrated, is totally destroyed, and is in direct continuation with the intra and extra bulbar portion of the tumor. Otherwise, the sclera presents only pigmentation around the vessels and nerves.

Of the anterior section of the bulb, in addition to the coalescence of the periphery of the iris to the cornea by pigmented new-formed tissue and numerous drusy thickenings of the membrane of Descemet, it is only to be mentioned that pigment in the form of granules was contained in Schlemm's canal and the adjacent tissue.

The extrabulbar tumor presents the same structure of a spindle-celled sarcoma as the intraocular one, only that here the unpigmented cells were far more predominant.

10 (618). This case has already been published by Knies, Graefe's Archiv, XXIII. 2, page 63, on account of the secondary glaucoma. The tumor has evidently proceeded from behind outwards, and extends externally as far as the ciliary body; internally, to about the equator; it projects relatively slightly into the interior of the eye (compare case 9). At the posterior pole the sclera is over a great extent destroyed, and there is here a direct transition into a large extrabulbar tumor, which completely incloses the optic nerve. There, where the tumor reaches the ciliary body, there is externally a considerable isolated tumor of the corneo-scleral margin, the size of a bean. Within, a portion of the normal choroid is still to be seen. The retina is entirely detached.

Microscopic (Dr. Knies).—The tumor is a slightly pigmented, small-celled spindle-celled sarcoma. Between the intraocular tumor, which extends in the suprachoroidal space forwards to beneath the membrane of Descemet, and the nodule on the corneo-scleral margin, there is a continuous connection through sarcoma-cells at the locality of an anterior ciliary vessel; otherwise, throughout between them the sclera is completely intact. The corneo-scleral margin and the canal of Schlemm contain free pigment. The transition of the tumor into the choroid is quite precipitous. Immediately adjacent to the steeply ele-

vated tumor the choroid, the inner layers of which cover the sarcoma for a distance, is entirely normal.

The retina is totally detached, and has undergone connective-tissue degeneration; the pigment epithelium adheres to the choroid; the optic nerve is free; the vaginal space is filled with sarcoma cells.

11 (....). B., painter, 49 years of age, attacked by iritis in 1875, which was treated in Prague. A retinal datachment was diagnosed in the fall of 1876 by Arlt, who mentioned his suspicion of a tumor. They spoke against this diagnosis in Prague. Inflammation occurred Christmas, 1876. Cold applications were ordered by the family physician, and the patient directed to return to Prague. He was there informed an induration of the lachrymal gland had ensued as the result of the cold applications. In February, 1877, B. was consequently treated for three weeks in Prague with blue ointment, but was dismissed unrelieved. At the end of March, however, enucleation was declared to be indicated, and a bad prognosis pronounced. At the commencement of April, the patient came to Dr. Just, at Zittau, in the following condition: The bulb very prominent, the sclera driven forwards in nodules at many places; cornea in commencing purulent destruction, large hypopyon; conjunctiva partly chemotic, partly but strongly injected. Sarcoma of the choroid was diagnosed, and enucleation at once performed; to do which, it was necessary to divide the external commissure. The tumor had perforated posteriorly, and the contents of the orbit were therefore removed as far as practicable. On the 8th of May, nothing remarkable having thus far occurred, and three days after the family physician had declared that the orbital cavity had a good appearance, the patient returned with considerable œdema of the lids and cheeks. A tumor, convex anteriorly, was to be seen and felt in the orbit. A periosteal exenteratio orbitæ was soon made. The tumor substance proved to be a melanotic sarcoma, and, therefore, a relapse.

Macroscopic.—The tumor is located externally to the optic nerve and extends forwards to the ora serrata. The sclera externally to the nerve, to an extent of about is 25 mm., is destroyed, and there is here a transition into a large extrabulbar tumor, to the inner side of which the apparently normal optic nerve passes.

The retina, with the exception of two small folds, one on the tumor and the other opposite it, is throughout in contact with the choroid or the tumor, but has not coalesced with the latter. The vitreous body is transformed into a whitish mass, which has coagulated in the alcohol.

Microscopic (Dr. Knies).—The non-vascular tumor consists of closely crowded small spindle or round cells, in a very scanty homogeneous intermediate substance. The extrabulbar and intraocular portions present a completely identical structure. The former is very sharply demarcated towards the adjacent orbital tissue by a thick layer of connective tissue, which forms a regular capsule. The border of the tumor towards the remaining choroid is quite sharp, so that immediately adjacent to the tumor quite normal choroid is met with. The optic nerve is completely proliferated over, and the retina, together with the central vessels, displaced inwards. The nerve itself is, however, free from tumor elements and presents a normal condition, although the vaginal space contains sarcoma-tissue. The retina, with the exception of the portion near the tumor immediately adjacent to the papilla, which is much thickened and permeated with hollow spaces, is normal even over the entire tumor, which is everywhere covered by the lamina elastica, and mostly also by moderately changed pigment epithelium. The latter is only in places somewhat more strongly proliferous or in part wanting. The retina, although, with the exception of a small fold, smoothly applied to the tumor, has nowhere coalesced with the latter. Only the ciliary portion of the retina has been destroyed at the side of the tumor. Opposite the tumor at the equator, there is a small detachment of the retina from exudation which has coagulated in the alcohol. Here, the somewhat proliferated pigment epithelium adheres to the choroid. At the margin of the elevation, the retina forms a fold which has taken place from a great thickening of the outer layers of the retina as far as the molecular layer (excl.).

The corpus ciliare is atrophic, the periphery of the iris coherent with the cornea, the sub-conjunctival connective tissue immensely œdematous on the tumor side, and infiltrated

with migratory cells. Nothing to be seen of a glaucomatous excavation, from the great distortion of the optic-nerve entrance.

The contents of the orbit, enucleated and examined, consisted only of fat-tissue with blood extravasation, without any tumor elements whatever.

12 (38). Pigmented fibro-sarcoma in a phthisical bulb. Anamnesis wanting.

Macroscopically the tumor and eyeball form a connected mass of a grayish-yellow color and lobular surface. In the transverse section the remains of the sclera and cornea are only discoverable with difficulty. About 3–4 mm. behind the cornea, there is a very loose dark-brown mass, the size of a pea, with a sharp demarcation.

Microscopic (Dr. Chodin).—Only traces of the normal tissues of the cornea and sclera are to be discovered. The former was perforated, and Descemet's membrane is in folds and detached from it. In places may also be seen remains of the lens and portions of its capsule. The black body, the size of a pea, consists of large, strongly pigmented bodies of irregular shape, and but few distinct pigment cells.

The great mass of the tumor consists only of fibrillated connective tissue, with pigment deposited in places. In the periphery, there are also numerous fine large spindle-shaped pigment-cells, and still further outwards, the latter are large and round. While the more centrally located cells are apparently degenerating, the peripheral ones appear more strongly proliferating, so that an appearance is produced which reminds one of certain forms of scirrhus.

13 (476). Enucleation was performed on Mrs. D. by Dr. Nagel, in February, 1875, in consequence of melano-sarcoma, which had already perforated anteriorly. Two years previously, the patient had received a blow on his eye from a flail.

The sarcoma is already in a very far advanced stage, so that remains of the original tissue are only to be discovered in the anterior section of the bulb. The cornea is thickened, the

anterior chamber filled with tumor substance, the centre of the lens, still recognizable as such, lies imbedded in the tumor-substance. The sclera is thickened somewhat anteriorly, and is gradually lost posteriorly in the tumor, which fills the entire cavity of the eye and is in continuous connection posteriorly with a large extrabulbar tumor. The latter extends outwards from the optic nerve 23 mm., inwards from it 15 mm. into the orbit, and proliferates forwards around the bulb from all sides. The optic nerve is likewise infiltrated.

Microscopic (Dr. Chodin).—The tumor is a small-celled spindle-celled sarcoma, with partly pigmented, partly unpigmented cells. The cornea is pannous, free from tumor; iris much thickened, infiltrated with sarcoma-cells, and passes over into the tumor-mass. The anterior capsule of the lens is folded, perforated, and without epithelium. Within the former, there is tumor-tissue, and only in places, mostly at the centre, there are remains of lens-fibres, which look as if corroded. The corpus ciliare completely degenerated, and hardly recognizable as such. Between it and the posterior capsule of the lens, there is new-formed bone-tissue forming a ring around the lens, which has apparently preceded from the detached retina, remains of which are still recognizable.

This bone-formation has vessels with pigmented walls, and lies *inwards from the still preserved lamina elastica choroideæ and the proliferated pigment epithelium.* The anterior part of the sclerotic is almost normal, containing tumor-cells only in its innermost strata and at the margin towards the cornea, where they have crowded into the vascular canals especially. Posteriorly it gradually thickens, from becoming more and more infiltrated by tumor-cells. The optic nerve consists microscopically only of tumor-substance. There is nowhere even a trace of normal choroid to be discovered.

14 (463). E. M., enucleated by Mooren in 1876 (No. 54, 741), on account of choroiditis ectatica; glaucoma which had run its course had previously existed, cf. Graefe's Archiv, XXIII. 2, p. 62, No. 17.

Macroscopic.—Eye globular, 24 mm. in all diameters; corneo-

scleral furrow obliterated; anterior chamber obliterated; the cornea is thickened and has small vessels. The corpus ciliare and iris are atrophic. In the inner half of the eye, bounded by the sclera, there is a loose, black mass extending from the ora serrata to the outer margin of the optic nerve. From this black mass, which looks like a considerable thickening of the choroid to a maximum of about 6 mm., a globular tumor passes somewhat inwards from the optic nerve, resting on it for a breadth of about 5 mm., nearly reaching the lens and filling the centre of the cavity of the eye, but nowhere touching its walls. In the anterior section of the vitreous space there are still found remains of detached retina; between the tumor and the walls of the cavity of the eye there is a homogeneous yellowish mass. The trunk of the optic nerve presents two black spots; the intervaginal space is likewise filled with a black mass. (See Becker, Photogr. Abbildung zu Serie iv. No. 39.)

Microscopic (Dr. Chodin).—The tumor consists of very dark, pigmented, more rounded cells and larger lumps of protoplasm, which are so closely overstrown with pigment granules that nothing can be decided concerning their cellular nature. Both these varieties lie in a scanty, transparent intermediate tissue, which also contains numerous aggregations of pigment and some pigment granules, and is but scantily provided with blood-vessels. The transition into the choroid is quite gradual. While the above-described conditions predominate at the centre of the tumor, making more the impression of a simple melanosis, the periphery consists of well-developed, mostly unpigmented spindle-cells, which may be still followed from the tumor far into the choroid, especially into its middle layers. Besides these developed spindle-cells, the choroid presents great thickening from the immensely distended blood-vessels, and very great infiltration, especially of the chorio-capillaris, with migratory cells, with which the walls of the vessels even in the sclera are also permeated. Still further from the tumor, the round-cell infiltration diminishes, and in its place there is œdema of the choroid. Its several layers are strongly forced apart and the intermediate spaces are filled with exudation

which has been stiffened by the hardening media. The latter contains numerous round and elliptic concretions which demonstrably arise from pigmented stroma-cells.

A complete layer is formed in the suprachoroideal space by this coagulated exudation through which pass only scanty connective-tissue trabeculæ and pigment-cells of the lamina fusca. The dilatation of the suprachoroideal space has advanced furthest at the ciliary body, which has thereby been lifted off from the sclera. A direct coalescence of the tumor with the sclera occurs only at a circumscribed place, and here the scleral vessels are pigmented. At the remaining places, the suprachoroideal space is also filled beneath the tumor with the amorphous exudation, and here the vessels of the sclera are not pigmented. The optic nerve presents a glaucomatous excavation which is filled by the tumor ; from here the nerve itself is also filled with pigmented tumor-cells, as is also its sheath at the inner side. Inwards from the optic nerve, pigmented ; outwards, unpigmented spindle-cells may be followed along a vessel (Art. cil. post. brevis ?) through the entire sclera.

The pigment epithelium, which is in contact throughout with the choroid, and for a distance also with the tumor, is strongly proliferating and permeated by numerous round cells. Only the anterior portions of the retina are to be recognized as such and contain pigment in granules. The remainder has disappeared, and appears to be substituted by the globular tumor resting on the sarcomatous choroid. Between the ciliary body and the detached retina there is so-called osteoid tissue with scanty vessels, some pigment, and a few round cells. This appears, in part at least, to have proceeded from the degenerated retina, as it is located within the lamina elastica choroideæ and pigment epithelium (comp. the preceding case). The portion of the bulb not occupied by the tumor is filled with hardened exudation with scanty concretions, numerous red and white blood-corpuscles, and aggregations of pigment.

The anterior section of the bulb presents total coalescence of the iris with the cornea and corpus ciliare. The corneo-scleral

margin and subconjunctival connective tissue are strongly infiltrated with cells. There is pigment in Schlemm's canal and its vicinity, and the appearance of pannus on the otherwise unchanged (containing round cells) cornea.

15 (602). Locksmith K., from Reichenberg, was wounded in the eye, in 1874, by the bounding of a turn screw. Eight weeks later Dr. Just saw him in Zittau. The eye was entirely blind; an effusion of blood in the anterior chamber prevented an examination, and, as there was no trouble complained of, no treatment was advised At the end of September, 1875, he returned with severe pain, a very tense bulb, chemotic, and strongly injected conjunctiva. In this condition the eye was enucleated by Dr. Just. Nothing could be seen with the opthalmoscope except a reddish-yellow reflex from the fundus.

Macroscopic.—The bulb is almost globularly round, from the middle point of the cornea to the papilla 24 mm., from here to the place of perforation at the region of the macula lutea 27.5 mm., greatest breadth 25.5 mm. The corneal furrow is obliterated, the anterior chamber is shallow, the lens globular, dislocated somewhat inwardly, the periphery of the iris coalesced with the cornea. Two-thirds of the bulbar space is filled by a spotted brown tumor, which appears to have proceeded from the macula lutea, where the sclera is also thinned, distended outward, and at a small place perforated. The tumor extends inward over the optic nerve and the median line, reaches nearly to the posterior pole of the lens, and continues outward into the strongly thickened choroid; this thickening reaches to the corpus ciliare. Only indications of the section of the retina corresponding to this side are to be discovered, while at the inner side the retina is detached by an effusion of blood, but appears to be still well preserved. The choroid appears normal at the inner side.

The true tumor is a globular mass of about 18 mm. in diameter (see figure in Becker's Photogr. Abbildungen zu Serie iv., No. 33).

Microscopic (Dr. Chodin).—The true tumor consists predominantly of fine unpigmented spindle-cells in a tolerably abundant

finely fibrillated intermediate substance, though there are very many pigmented spindle-cells intermingled with the unpigmented. While in the centre of the tumor the pigment is not very abundant, and lies in granules and aggregations in the intermediate substance; there is at the periphery a very great proliferation of pigment-cells, which evidently belonged to the stroma, and frequently present a reticular form. Together with numerous blood-vessels are also found small cavities filled with coagulated substance.

The transition into the choroid is quite gradual. The latter presents dilated blood-vessels and strong infiltration, especially of the chorio-capillaris, with migratory cells, which may, however, be distinctly distinguished from the sarcomatous spindle-cells, the rows of which are found far removed from the tumor in the middle layers of the choroid. The nearer the tumor, the greater the proliferation of the pigmented stroma-cells, which are evidently frequently destroyed thereby, thus setting their pigment free.

The lamina elastica and pigment epithelium may be followed for a distance over the tumor. The latter is over the tumor, as well as over the whole choroid, in strong proliferation, and permeated with numerous round cells and red blood-corpuscles.

The sclera presents infiltration of its innermost lamellæ with partly colored, partly white tumor-cells, which are especially diffused along the vessels. The infiltration increases towards the place of perforation, and the perforation itself took place through a vascular aperture, as is still indicated by the arrangement of the scleral elements, and corresponds in situation pretty accurately to the macula lutea. The optic nerve presents pigmentation and infiltration with tumor elements, especially at the tumor side, and may be followed to the end of the section.

At the tumor side only remains of the retina can be recognized, which adhere to the ora serrata. Farther forwards, the pars ciliaris retinæ is detached from the atrophic corpus ciliaris by an effusion of blood. At the inner side of the eye the retina is still tolerably well preserved, and is detached from the

choroid by bloody effusion and coagulated exudation. The strongly proliferating pigment epithelium adheres to the choroid. The bulbar space, in addition to the tumor, is filled with a fine granular exudation, with much free pigment and pigment contained in cells, and numerous white, and especially also red blood-corpuscles.

The ciliary body is very atrophic; between it and the lens lies an exudation very rich in cells. The periphery of the iris has coalesced with the cornea by pigmented tissue. Pigment is found in Schlemm's canal and its vicinity.

The cornea presents pannus, with numerous round cells between the uppermost strata and between the deeper layers of the anterior epithelium.

16 (704). P. A., 40 years old, from Obernburg, in Bavaria, came September 7th, 1874, to Dr. Steffan, at Frankfort on the Main. An injury had been received just previously.

Status at that time: Leucoma corneæ both sides.

Right: Hemorrhage in the vitreous body, probably with simultaneous detachment of the retina. Counts fingers at 4 to 5 feet; field of vision free only a little below; tension not increased.

Left: Vision = $\frac{12}{40}$; letters with emmetropia; field of vision free.

March 27th, 1876, left vision, $\frac{12}{70}$; field of vision defective externally; nothing found with the mirror.

Right: A perforating melanotic sarcoma of the choroid. Patient much depressed; appears cachectic, with 112 beats of the pulse to the minute.

March 28th, 1876.—Enucleation by Dr. Steffan; the optic nerve was found affected. Probably the affection reaches as far as the chiasma, and there causes the defect of vision of the other eye.

According to oral information, the patient died at home six weeks later, from loss of strength (?).

Macroscopic.—The bulb is of normal dimensions; a nodular tumor rests on the corneo-scleral margin. The iris is indistinct; the lens is dislocated backwards and somewhat outwards; the sclera appears intact; the entire bulbar cavity is filled with tumor-substance, which contains numerous cysts, and permits only of the conjecture of the various tissues, such

as the retina and ciliary body (see the representation, fig. 2). The optic nerve and its sheaths are strongly thickened, and pass continuously into the tumor.

Fig. 2. $\frac{2}{1}$.

Microscopic (Dr. Knies).—The entire contents of the bulb, with the exception of the lens, present the structure of an alveolar sarcoma. There are large epithelial-like cells, with large nuclei and distinct nucleoli, several of which lie in each of the alveoli, which are bounded by fibrillated connective tissue. The very irregularly distributed pigment is partly free, partly contained in large protoplasma lumps; the true tumor-cells but rarely contain pigment. While macroscopically the limits of the several tissues are still recognizable with difficulty, microscopically, everything has been uniformly absorbed by the tumor. It can only be ascertained that that which superficially appears to be the choroid is nothing but the suprachoroideal space stuffed full of tumor-cells, and thickened in places to 1 mm. The tumor substance filling this passes anteriorly directly into the iris, posteriorly into the optic nerve and its sheath. The latter, as far as the end of the section, is filled with sarcoma tissue; while, with the exception of the head of

the optic nerve, which is diffusedly infiltrated, in the optic nerve itself only several small tumors are met with connected to each other, and the cut end appears to be free. Close beside the optic nerve and its infiltrated sheath the vessels appear entirely free. Shreds of an endothelial membrane may be isolated in places from the cyst walls. The contents of the cysts was a fluid which contained only a few tumor-cells as formed elements. Nothing is to be discovered microscopically of the retina; it is completely transformed into sarcomatous tissue.

In the vicinity of the corpus ciliaris the chorio-capillaris may occasionally be recognized as a smaller layer filled with blood. The pigment epithelium is here in a condition of strong proliferation, and is permeated with tumor-cells; the remaining choroideal layers are transformed into sarcoma tissue.

The innermost layers of the sclera are crowded apart and present infiltration with sarcoma-cells, which are readily distinguishable in this tumor from other cellular elements, on account of their size and form. Further outwards the sclera only occasionally presents pigmentation, and nowhere can tumor-elements be discovered in or near vessels. A direct communication of the internal and external tumor by true sarcoma-cells can only be recognized along one of the anterior ciliary vessels, outwards at the corneo-scleral margin, where the secondary tumor rests.

Columns of tumor-cells press from the sarcomatously degenerated iris into the corneo-scleral margin (here the cornea and sclera are regularly crowded apart inwards), and towards the canal of Schlemm. They may be followed from here forwards into the cornea, especially under Descemet's membrane, as well as backwards into the sclera for a considerable distance. The ciliary body is in places completely transformed into tumor-tissue, where the secondary tumor rests without. At other places it is still tolerably free, while the iris is entirely degenerated. Here may be recognized the presence of a glaucomatous synechia and immense dilatation of Leber's venous plexus. The cornea is permeated superficially with round cells. The extrabulbar tumor presses forwards beneath the anterior epi-

thelium. At the same time, however, it presses from without into the corneo-scleral margin, and sends processes under Bowman's membrane and into the corneal tissue, and also, though less extended, backwards into the sclera. Notwithstanding the tumor infiltration of the corneo-scleral margin from without and within often approach tolerably near, a direct connection of the intraocular and extrabulbar tumor is only to be discovered at the already-mentioned anterior ciliary vessel.

II.

1. The above-described cases present *tumor formations in the choroid in the most various stages of their growth.* Cases 1 and 2 are, so far as I know, the earliest commencement conditions thus far anatomically examined, though it is true such have already been frequently observed clinically.

Besides the seven cases published by Becker, l. c., and our case 1, may also be mentioned: Graefe in Archiv für Ophthalmologie, XII. 2, page 238, two cases without retinal detachment, where confluent white spots of the retina were the first of ophthalmoscopic discoveries, and by the same in Zehender's Monatsblätter, 1869, page 161, ff., where a round retinal detachment was observed at the macula lutea. Naturally, tumors of the choroid, which occurred at other places than the macula lutea, might accidentally come under observation, in consequence of the slight or entirely wanting subjective manifestations, and such a preparation would be still more difficult to obtain, as no one would hardly dare to enucleate without pressing subjective symptoms.

2. All the choroidal sarcomata examined by us had their *origin*—where this was demonstrable—*in the posterior section of the bulb*, and with this agree also the observations and experiences of Brière (l. c.), and Berthold (A. f. Ophth., XV. 1, page 159), that the choroideal sarcomata most frequently originate in the fundus oculi, while Wecker (Graefe-Saemisch, Handbuch, Band IV., page 650), asserts of the melano-sarcomata that they most

frequently arise in the anterior section of the bulb anterior to the equator.

3. Thus far, there have been pretty generally accepted as *stages in the development of sarcoma:* a so-called primary, up to the entrance of glaucomatous (especially pain) manifestations, a stadium glaucomatosum, and a stadium perforationis, where, probably without exception, after the removal, local or general relapse usually occurs. This division, essentially the result of a clinical point of view, presents defects in several regards. Firstly, these stadia, with the exception of the third, correspond to no decided phases in the growth of the tumor, for secondary glaucoma may occur very early; this may also be entirely wanting, however, in spite of perforation and extrabulbar proliferation. Secondly, these commencing stages vary in their sequence according to the location of the tumor; and thirdly, their determination in a prognostic regard is doubtful. From a purely anatomical standpoint may be proposed the acceptation of an *intrachoroideal*, *an intrabulbar*, and an *extrabulbar* stage of development. This division would correspond to the originally purely local nature of the affection, and would give the sole point of support for the prognosis. The earlier or later occurrence of glaucomatous manifestations has, indeed, the value that, for the most part, it chiefly calls attention to the disease and disposes the patient to receive judicious advice; but for the determination of the individual cases, it has only a secondary value.

The difficult point of our division lies, in addition to the anatomical relations, in the prognostic signification. In the first and second stage, the prognosis is good; in the third, bad, or, at least, very doubtful, as cases in which a permanent cure followed the extrabulbar developments, are, at all events, of the greatest rarity. Compare Knapp, l. c., case 9; though the observed duration of the cure extends only to three years, so that it may still appear somewhat questionable whether it can be considered as definitive.

In consequence of the rarity with which the first stage comes under clinical or even anatomical observation, it is practically

appropriate to include the two first forms in one, and to distinguish only an intra and extra bulbar stage of growth ; the period at which glaucoma occurs is irrelevant.

Of our five cases with merely intrabulbar affection, three were with, two without glaucomatous manifestations ; in all, accordingly, a good prognosis was to be given (except case 4, where there was eventually an affection of both sides. The three patients of whom we were able to obtain information in fact still enjoy good health, notwithstanding that one of them was not operated upon until the occurrence of the so-called stadium glaucomatosum. Though, in the interest of the patient, an accurate examination of an eye enucleated on account of a tumor is not to be omitted, this division of the two mentioned stages of development also retains its value in a clinical regard, although a decision concerning it can only be given after a certain time.

4. That *sarcomata of the choroid in their first commencement lie in the choroid* is directly evidenced by the intrachoroideal nodule at the equator, in case 2, should it be regarded, not as a metastasis, but rather as a primary nodule. It is still further evidenced, however, by further developed tumors. Thus, when of a tolerable size, it is frequently covered by the chorio-capillaris, lamina elastica, and pigment epithelium ; while, it is true, perforation of the suprachoroidea and coalescence with the sclera usually occurs at an early period. Even here, this almost always occurs centrally, and the suprachoroideal space appears to be previously obliterated by adhesive inflammation, since it would otherwise be difficult to conceive that the tumor should so rarely spread out in the suprachoroideal space, to which *a priori* it must be considered especially disposed.

4. We have not been able to find a confirmation of the *origin of the round-celled sarcoma from the chorio-capillaris*, as accepted by Knapp. On the contrary, the two forms do not usually differ, either in making their appearance or in their extension. It is true that, with a certain smallness of the tumor elements, it is often impossible to distinguish what is only emigrated white blood-corpuscle from an actual sarcoma cell, both of

which it is necessary, however, to keep distinct from each other. Since the chorio-capillaris (see case 14) occasionally presents strong infiltration over the tumor with migratory cells, the discrimination is indeed difficult with round-celled sarcomata. It also happens with round-celled sarcomata, however, that the chorio-capillaris is normal (cases 2 and 5), and here, also, the tumor is covered far over by it. Since the further diffusion of the sarcomata is the same, whether they consist of spindle or round cells, we consider ourselves justified in maintaining the same matrix for both forms, and in locating it for both forms in the middle layers of the choroid.

While, as has already been said, the suprachoroid is early perforated, and coalescence with the sclera takes place, the inner strata of the choroid usually resist for a longer period, and here the lamina elastica comes essentially into consideration. At first the chorio-capillaris is transformed into tumor-tissue, and this leads in rare cases to the formation of regular cavernous tissue, cf. Klebs, Archiv für Ophthalmologie, XI. 2, p. 253; generally, however, nothing farther is noticed of it in the centre of the tumor, and the latter is covered only by the lamina elastica. This is occasionally thickened by superimposed new-formed tissue (cases 2 and 3), which consists of concentric striated connective tissue with remains of pigment epithelium and less numerous migratory cells, which latter probably originate in the chorio-capillaris. After a shorter or longer period, a regular perforation of the lamina elastica occurs, probably less from wearing away than from tearing, as a result of the rapid growth of the tumor, and this may not be hindered by the great thickening from the superimposed tissue (case 3). With a slower growth, however, the lamina elastica may long remain uninjured, as, for example, in case 2, especially when, as just in the example adduced, the tumor early assumes chiefly an extra-bulbar diffusion.

6. The *pigment epithelium* is proliferous over the tumor, and generally also to a greater or less extent around it. In the slighter grades, there is enlargement of its cells without increase of the pigment. In the higher grades, proliferation

appears possible, often with a great increase of the pigment. A great number of the cells are thus destroyed and their contents become free. Large, highly pigmented lumps of protoplasm without a recognizable nucleus are then found together with cells in the most varying stages of destruction. Very frequently there is found herewith an immigration of pigment into the otherwise well-preserved or already changed retina. These processes of proliferation are to be met with in the same eye, often of the most varying intensity. Occasionally, from unknown causes, circumscribed, highly intense processes of proliferation occur in the pigment epithelium at certain places, and true melanoma nodules are thereby formed, as in cases 6, 8, and probably also 13. For further particulars we may refer to the histories of the cases.

7. The *further growth of the sarcoma* takes place by the fungus-like proliferation of the tumor in all directions, after it has been relieved from the pressure of the elastica by perforating it. Various events may then occur, which depend essentially on the condition of the retina. This leads us, entirely of itself, to the question of the detachment of the retina in sarcoma of the choroid. As is known, the original opinion was (v. Graefe) that retinal detachment took place at a very early period, and that this was the rule almost without exception. Knapp was the first who published a case where tolerably late there was still no detachment of the retina present (cf. Zehender's Monatsblätter, 1862, Discussion on Knapp's Article in the Transactions of the Ophthalmological Society). These observations have since constantly accumulated (Becker, l.c.; Knapp, l.c., case 13, which called forth the above-mentioned discussion; Hirschberg, Zehender's Monatsblätter, 1868, p. 163, ff.; Landesberg, Graefe's Archiv, XI. 1, p. 58, etc.). In our cases 1, 2, 3, 6, 11, the retina was also found attached. While this was formerly considered applicable only to sarcoma of the pars ciliaris choroideæ in consequence of the firmer connection with the corresponding portions of the retina (Wecker), it appears to be exactly those occurring in the region of the macula lutea, where

for a long time no complete detachment of the retina takes place (compare most of the above-cited cases).

8. The *mechanism of the detachment of the retina* from sarcoma of the choroid appears to us, according to the cases examined, to be the following. The first occurrence is œdema of the retina, whereby at once the connection between the pigment epithelium and the rod-layer appears to be considerably loosened. How far the proliferation of the pigment epithelium may contribute to the latter we were unfortunately unable to determine, as it may possibly not occur till after the detachment. In our cases, the pigment epithelium always remained attached to the choroid, which is also mentioned by Hirschberg (Graefe's Archiv, XXII. 1, p. 135) and Dor (Graefe's Archiv, VI. 2, p. 244). At those places where during life the retina was attached, in the separation of the retina by the preparation the pigment remained on the rod-layer. All the layers of the retina were not uniformly thickened, however, by the œdema; this occurs chiefly in the outer layers (case 11). The formation of folds is hereby induced, as has already been mentioned by Goldzieher in connection with detachment of the retina. That this does occur is shown, among other circumstances, by the fact that the margin of the retinal detachment is always formed by an especially distinct fold. If by this means the connection between the retina and the choroid is loosened, and even but a minimal quantity of fluid be present between the two, only a slight impulse is necessary from the perpetual current of fluid from the choroid to the retina to render the detachment complete. If, therefore, as appears very probable to us, œdema of the retina is the first stage of detachment, it is very easily explainable why exactly in sarcoma of the macular region it is so frequently wanting, because hereby the flow of blood in the retinal vessels is not impeded, and, consequently, no cause for the production of œdema is present. We have already referred (Knies, Graefe's Archiv, XXII. 3, p. 163, at case 13) to the possibility of another origin of retinal detachment; namely, by shrinking of the strongly thickened limitans interna, from which the formation of folds must likewise result. This might

also come in question in connection with retinal detachment in tumors of the choroid, as the mentioned strong thickening of the limitans interna is frequently found.

9. *Should the retina, however, remain attached to the tumor, it either remains for a long time unchanged* (case 11), *or it coalesces with it.* The latter, it is true, rarely occurs to a great extent, but various modalities may hereby occur. In the first place, the retina might coalesce with the choroidal remains covering the tumor, either by the entire surface or only by the summits of the folds eventually formed by the œdema. Still, we have not found this occurrence in the cases examined by us. The same varieties of coalescence may also take place with the new-formed tissue on the lamina elastica (cases 2 and 3), whereby the tumor may subsequently perforate the membrana elastica and the new-formed tissue (case 3). Concerning the proliferations in the rod-layer occurring hereby, compare the relative cases in the text; Nettleship (Ophthalmic Hospital Reports, VIII., p. 267), Brailey (*ibidem*, VIII., p. 298), and perhaps also Socin (Virchow's Archiv, LII., p. 550 at case 6), appear to have seen something similar, and Hirschberg (Graefe's Archiv, XXII. 1, p. 135, plates IV. and V.) gives a representation of this, though with but slight enlargement. The coalescence of the retina may, finally, also take place with the tumor itself after perforation of the lamina elastica choroidæ (case 1). This may be the case with the totally detached retina, when it is reached by the growing tumor (case 5).

10. A penetration of tumor elements into the œdematous and degenerated retina does not take place at once, as is shown, for example, by case 1; *the retina appears to be perforated tolerably soon*, however, and *then the tumor proliferates in the vitreous cavity.* The tissue of the retina, the elementary tissues of which are just here forced apart by the œdema, is hereby opened for the sarcoma-cells, and rapid and profuse proliferation appears to occur in it. Such a proliferation into the retina and its infiltration for a distance with tumor-cells, disregarding far advanced cases, has occurred in our observations 3 7, and 9. Perforation into the vitreous body occurred in cases

5 and 9, comp. Knapp, l. c., case 14. In place of the perforation, however, the coherent retina may again be detached, as is indicated by several of our preparations, which is also apparently referred to by Nettleship, Ophthalmic Hospital Reports, VIII., p. 267, and which Brailey, *ibidem*, VIII., p. 541, directly maintains.

11. Let us now pass to the *further diffusion of the tumor within the choroid itself.* The latter may, in the immediate vicinity of the tumor, be completely normal, or, at most, somewhat thickened from mechanical expansion of the vessels and œdematous separation of its layers (cases 1, 2, 5, 8, 9, 10, 11). This occurs, as it appears, only in genuine or spontaneous sarcoma. The margin of the tumor is in such cases extremely sharp, and may be steep, or even arise overhanging from the completely normal choroid (cases 1, 2, 5, 8, 10, 11); in other cases it sends off tongue-shaped processes into the choroid. Frequently both varieties of growth occur at different sides of the same tumor, and this appears to depend on the rapidity of the growth in the several directions. Hereby the tumor, pressing the layers of the choroid apart, is furtherest advanced in the strata of the large vessels, and is covered inwards by the chorio-capillaris, lamina elastica, and pigment epithelium, outwards by the suprachoroidea for a greater or less distance. In other cases, the choroid presents greater or lesser infiltration with migratory cells in various extents around the tumor, which may increase to a regular purulent choroiditis. Most of the cells are naturally located in the chorio-capillaris; but the walls of the veins in the stratum of the coarser vessels of the choroid and even in the sclera are stuck full of emigrated white blood-corpuscles. Nevertheless, a sharp tumor boundary may also often be found in such cases (case 3). In round-celled sarcoma this is naturally more difficult, as it is often impossible to decide whether one has to do with an emigrated cell or a sarcoma cell; though even here a steep elevation of the tumor from the strongly infiltrated choroid may also occur, as our case 4 shows.

12. *Another variety of the limitation of the tumor toward*

the choroid is this, that it sends off processes for a greater or less distance into the scarcely thickened choroid, gradually becomes elevated, and, in short, passes more or less diffusely into the adjacent tissues. This occurs in our cases 6, 7, 9, 14, 15, while in cases 12 and 13 nothing more was to be seen of the choroid in consequence of the affection having advanced too far. In case 6, the anamnesis is unfortunately wanting; in case 9, the diffuse demarcation was perhaps due to the tumor having early perforated, and thus having predominantly proliferated extrabulbar, and thus, besides our case 7, only the two traumatic sarcomata 15 and 16, and case 14 remain. If we now consider the so-called traumatic sarcoma only as a tumor formation occurring in an eye which is already previously deeply diseased and changed, this relation may be explained in the most unconstrained manner, and we may add case 14 as a sarcoma in a bulb which was already diseased, on account of the similarity of its structure, to the actually traumatic sarcoma, as has also been done in this article. If the œdema, which is almost always present in the vicinity of the tumor, affords great assistance to the diffusion of the latter by loosening the tissue, this must be still more the case when deeply acting inflammatory processes have taken place for a longer period. We would not assert by this that a tumor formation, which is from the first diffuse, is not possible; on the contrary, case 16 may be very well considered as a diffuse sarcosis of the uveal tract. In an advanced stage, it is no longer possible to decide whether the process has been diffuse from the commencement, or has only become so by rapid spreading. Case 7 would, indeed, also speak in favor of a diffuse origin, were it not that the quite gradual transition depended only on the extremely slow growth observed there, or on the predominantly extrachoroidal growth as in case 9, but into the vitreous body. Rapid growth with a profuse spreading within the choroid might accordingly be regarded as characteristic of the traumatic sarcoma, or, at least, of one occurring in a deeply diseased eye, while with a slow growth it also occurs in spontaneous sarcomas (cases 7 and 9). By

this only a possibility is mentioned, which results from the consideration of our sixteen cases; though Lawson also says in the Ophthalmic Hospital Reports, VII., p. 283, in reference to a traumatic sarcoma: " . . . It is perhaps not improbable that the peculiarly different arrangement of the sarcomatous deposit in the choroid was in some way dependent upon changes which occurred before the commencement of malignant action," which is in tolerable harmony with our view, that the various methods of diffusion depend on the changes caused in the eye by the trauma (or by other causes).

13. The literature of *traumatic sarcoma* is far from rich, especially if we exclude sarcoma of the phthisical eye. We can only adduce with certainty as traumatic sarcoma: Lawrence (Ophth. Hosp. Reports, VI., p. 168), Hart (*ibidem*, p. 169), Lawson (*ibidem*, VII., p. 277), which possesses great similarity with our case 16, and where an analogous case is also mentioned by Streatfield: Nettleship (*ibidem*, VIII., p. 264) and Raab (Zehender's Monatsblätter, 1875, p. 239), which have some similarity: in the last case a foreign body was found in the sarcoma mass. Raab has also, l. c., presented a few cases which were inaccessible to us, and of which we cannot, therefore, form an opinion. Graefe (A. f. Ophthal., XIV. 2, p. 124) describes a traumatic sarcoma in a man twenty-four years of age. The tolerably analogous cases of Quaglino (Nagel's Jahresbericht, 1871, p. 269), and Knapp (l. c., p. 149), are only to be considered with caution as sarcoma, in consequence of the simultaneous presence of pus formation in the tumor, and likewise the case of Landesberg (Zehender's Monatsblätter, 1873, p. 487) may be unconstrainedly declared to be a metastatic choroiditis. To a certain grade it is not possible to distinguish histologically young cicatricial tissue from spindle-celled sarcoma, and granulations from round-celled sarcoma. The much more numerously observed sarcoma in phthisical eyes we will not cite, as they lead too far from the special theme, but chiefly because the histological details are here for the most part unrecognizable, and therefore definite conclusions are impracticable concerning what is found (comp. our case 12).

14. In regard to the *extrabulbar growth of the sarcoma*, we have in all our cases, with the exception of case 8, to which we shall again refer, been able to recognize the continuous connection between the intra and extra bulbar tumors. Graefe (A. f. Ophth., XIV. 2, p. 103) considers extrabulbar development without perforation as by far the most frequent, and propagation through the optic nerve as relatively at least seldom. Berthold (Graefe's Arch. XV. 1, p. 159) did not find one single perforation in eight cases. Even later there is much more frequently no connection to be found; but rarely are actual perforations mentioned; for example, Nettleship (Ophth. Hosp. Reports, VII., pp. 385, 389, 611), Graefe (Archiv für Ophth., X. 1, p. 276, Knapp (l. c., case 10). We do not here refer to the communication after extended destruction of the sclera, such as is frequently found in advanced cases, but rather the connection of the apparently isolated extrabulbar tumors with a sclera as intact as possible. Normal places in the sclera for the passage of vessels and nerves could always be recognized as the locality of the perforation, and as these are known, it is not difficult to predict with some certainty where the places of perforation are to be found. The perforation of the sclera is preceded by that of the suprachoroid, both of which occur in the centre of the tumor. The tumor then coalesces with the sclera, and the innermost lamellæ of the latter are forced apart and filled with tumor-cells. That hereby the suprachoroideal space in the vicinity of the place of coalescence usually grows together has already been mentioned, and this corresponds exactly with what occurs in other serous membranes. The suprachoroideal space is, however, often still present; while externally to it the sclera is permeated by numbers of sarcoma-cells. An ectasia of the sclera without any considerable thinning may early occur, and also without the tumor infection being far advanced (case 1). The pressing apart of the scleral layers may, however, proceed very slowly, and we have never seen a perforation occur from this alone, although the possibility was present. The latter only took place after the tumor elements had reached an opening for a vessel. Perforation

along a nerve (exclusive of the optic nerve) we have observed but once (case 6), and even here only of pigment; it is probable that this is in consequence of the unfavorable direction in which the nerve passes through the sclera. The pressing apart of the scleral fibres and the perforation at normal emissaries is preceded, also in leuco-sarcoma, by more or less intense pigmentation. The pigment lies either free as granules in the juice canals of the sclera, and in loose connective tissue around the vessels, or it is contained in the cells occurring normally in the places in question. The normal discharge of the intraocular fluids also corresponds with the fact that pigment is often met with quite early at the corneo-scleral margin, especially in the vicinity of Schlemm's canal (4, 5, 6, 9, 10, 14, 15), and often also in the new-formed tissue which is produced by the glaucomatous synechia of the iris. In all the cases observed by us, the sclera was pigmented for a greater or lesser distance in the vicinity of the tumor. The free pigment is found in the same paths which are later followed by the tumor-cells, and there can be no doubt that this arises either from the tumor itself or from the tissue-cells (pigment epithelium and pigment-cells of the choroid) which are becoming destroyed at the margins of the growth. This natural pigment injection of the efferent lymph-vessels, as the phenomena may becalled, appears to be irrevelant in regard to the prognosis, as it may also be met with in places passing through the sclera, where on the outer side no trace of tumor is to be found. It is therefore to be distinguished from the actual perforation by tumor-cells. It is also to be mentioned that a pigmentation of the corneo-scleral margin is only to be met with after perforation or, at least, pigmentation of the retina (6).

15. *The time and place of the actual perforation* depend in great part on the location of the tumor. It may acquire a considerable size, and yet remain intraocular when it occurs at a place where no scleral passages are normally present (for example, case 5), or a perforation may occur early, when such a passage is in the vicinity, as is especially true of the tumors of the macular region (cf. cases 2 and 9), as Becker (l. c., p. 227)

has already remarked. As several scleral emissaries are to be found directly in the region of the macula, the condition mentioned is quite natural. Further on, one often finds vessels used, within and without, near the optic nerve. Perforation by the way of a vena vorticosa we have not observed in our cases, which is probably accidental. Since, accordingly, the places of perforation depend on the openings for vessels, it follows quite naturally that they may very frequently have a quite eccentric location, and since the extrabulbar tumor may also grow with varying rapidity towards various directions, they may often be difficult to find.

Our case 8 cannot come into consideration in opposition to *the almost constant discovery of an actual perforation*, as the optic nerve and its environs, which is just the place of predilection corresponding to the locality of the tumor, had previously been cut out and could not be examined. That it is important for the object of the examination to prepare sections as meridional as possible is, indeed, self-evident, from the slight extension of the scleral emissaries. Tumor elements may penetrate from the places of perforation in question in all directions into the sclera, so that a regular nodule may be formed in the latter (case 7). In its further course, the sclera is completely destroyed, so that the intra and extra bulbar portions of the tumor are in broad communication.

An additional locality in the posterior section of the bulb, where perforation frequently occurs, is the optic nerve; it is here, naturally, much more readily recognized and also longest known. Pigmentation may also precede tumor infiltration in the optic nerve. The mode of the diffusion is here various; either sarcoma penetrate from the sarcomatously-degenerated retina into the optic nerve (cases 3, 9 and 14), or, which is more frequently the case, the elements pass from the glaucomatous excavation, which is filled with tumor substance, along the central vessels, into the nerve, and from there spread into its substance (cases 6, 7, etc.). Frequently, the vaginal space, which presents a more favorable field for the growth of the tumor, is also attacked, either from the optic nerve (case

9), or directly from the tumor, without the participation of the nerve (for example, cases 10 and 11). Occasionally, the infection of the vaginal space also takes place from an extra bulbar tumor (case 7). The infiltration and pigmentation is usually confined to the tumor side (cases 7, 14, etc.), or, at least, is more intense at that side (case 6). A third place of predilection for perforation with intact walls of the bulb is the anterior section of the eye. An anterior ciliary vessel was three times noticed as the point of passage (cases 10, 13, and 16). Perforation appears to occur still more frequently in the corneo-scleral margin, at the insertion of the iris (cases 7, 8, 13, and 16). At the place where the chief quantity of the fluid usually leaves the eye, the tumor elements penetrate either directly from the iris, or, as in case 7, after perforation of the membrane of Descemet. The further penetration does not here appear to take place with especial facility, as an actual perforation from here with an extrabulbar tumor formation was not noticed in our cases (with the exception, perhaps, of case 7). From the corneo-scleral margin there is then penetration into the cornea, especially under the membrane of Descemet and backwards, into the sclera. The corneo-scleral margin may also be infected from the extrabulbar portions of the tumor, as in case 14. In several of our cases, several perforations also occurred; in case 14, this was even recognizable in four places.

16. The so frequent and *early occurrence of secondary glaucoma* must, disregarding the mechanical influence of the growing tumor, probably be explained by the irritation which the chemically positive matters arising from the tumor exert at their exit from the eye on the corresponding tissues. That this is very probable is shown by the so frequent discovery of pigment at the corneo-scleral margin and the coalescent tissue of the synechiæ, which is, at all events, in connection with the tumor formation. The tumor, in coalescing with the sclera at its periphery, also causes adhesive inflammation in the suprachoroideal space, which may also be regarded as a somewhat analogous process.

It was very interesting to me to find an observation of

Brière's, where pigmentation externally of a vessel was recognized with a tumor formation in an eye which was then enucleated in the so-called stadium glaucomatosum. "La veine émissaire de la partie inféro-externe est plus visible que les autres et paraıt remplie d'une matière noire qui lui donne une coloration plus sombre que ne la produit dans les autres le peu de sang, qu'elles renferment" (l. c., p. 49). The patient was still well twenty-one months after the removal of the eye, which might perhaps speak for the innocuousness of the mere pigmentation, should the cure prove to be definite.

17. In connection with the phenomena occurring *in the later stages* of tumor formation in the eye, we would say a few words concerning *ossification:* In our case 13, the new-formed bone-tissue, and in case 14, the osteoid tissue was located inwards from the lamina elastica of the uveal tract, and inwards from the pigment epithelium, which would speak against the exclusive origin from the choroid (Knapp). Pagenstecher and Genth, in their Atlas, represent the new bone-formation at exactly the same place. Whether, however, the ossification proceeded from the detached retina, the remains of which were in direct application to the bone-formation, or, which Arlt regards as the most frequent, is formed from an exudation coming from the choroidal tract, we do not dare to determine, in consequence of the strongly degenerated condition of the retina.

18. Concerning the *various forms of the tumors* which were observed in our cases, there is little special to communicate. There were four round-celled, nine spindle-celled, and two alveolar sarcomas noticed; while the tumor in case 12 would be best designated as a fibro-sarcoma. The tumors were predominantly slightly pigmented. In cases 1, 2, 3, 8, and 11 they were almost white; while a considerable pigmentation was noticed only in cases 7, 9, and 11. Since the tumors examined in the commencement periods were nearly free from pigment, and the most peripherally located portions of the tumors were almost always but slightly pigmented, we were almost inclined to consider the pigmentation of the choroidal sarcomata as

something quite unessential, especially as the new-formation of pigment could almost always be traced back to the stroma-cells and the pigment epithelium (melanoma nodules). The quite peripheral, slightly pigmented zone of the tumor was generally followed by a strongly pigmented one, with stellate cells and large lumps of pigment; while the centre of the tumor was again clear. It is also true, however, that we could perceive in various places that pigmented and unpigmented true sarcoma-cells were lying directly alongside of each other, and we did not meet in our cases with especially deeply-colored tumors, so that only a very relative value is to be ascribed to the above-mentioned conjecture.

We might also mention the fact that our case 16 is to be regarded as a cysto-sarcoma, the occurrence of which is doubted by Knapp, l. c., notwithstanding Cowell's case in the Ophthalmic Hospital Reports, V., p. 188. Lawson (Ophth. Hosp. Reports, VII., p. 277), has also described a case similar to the one observed by us, so that the actual occurrence of cysto-sarcoma of the choroid can no longer be combated. It is certainly to be recommended, in the place of this very comprehensive name, to use more stringently the one of sarcoma cysticum s. lacunare (Virchow, Geschwülste, II., p. 191).

19. Case 4 brings us in a natural manner to the *double-sidedness of choroidal tumors*, which, in glioma, as is known, is quite frequent. We succeeded in finding in the literature but two relevant cases, one by Schiess-Gemuseus in Virchow's Archiv, XXXIII., p. 495, which is, however, more than uncertain, and is more readily explainable as a choroidal tuberculosis, which the author (l. c., p. 498) has also mentioned. In the second case, by Landesberg (Graefe's Archiv, XV. 1, p. 210), the anatomical examination of the last diseased eye is, it is true, wanting, but the analogy of the objective and subjective phenomena in both eyes, the symmetrical location, etc., afford a high degree of probability (the course in the second eye is very similar to our case), as an undoubted spindle-celled sarcoma was found in the enucleated eye. Nevertheless, in con-

sequence of the very great rarity of a double-sided choroideal sarcoma and the uncertain results of the examination, in our case 4 the acceptation of a much more frequently observed sympathetic affection of the second eye is to be maintained.

20. Our cases presented nothing especial concerning *the age of persons affected with sarcoma.* The youngest individual was 28 years of age (case 3). We might also remark that a whole series of partly true, partly doubtful choroidal sarcomas has already been described as occurring in children. Traumata were for the most part given as causes. In many cases, however, the occurrence of purulent foci rendered the diagnosis suspicious. The most interesting cases are two communicated by Hirschberg. One in Zehender's Monatsblätter, 1869, p. 83, in a girl eight years of age, whose retina was entirely free, and the other in Graefe's Archiv, XXII. 1, p. 135, of a small, yellowish, unpigmented, round-celled sarcoma, with nodules in the otherwise well-preserved retina of a child two years of age. The case mentioned by Steudner (Virchow's Archiv, LIX., p. 421) of an alveolar sarcoma of the retina and choroid in a child should also, according to the nature of the tumor, be regarded as a choroidal tumor.

21. In mentioning, in conclusion, the *duration of the cure*, we are gratified in being able to add three others, in cases 1, 2, and 3, to the by no means considerable number of definite recoveries. Enduring cures of 13 and 20 years are mentioned by Weber, of 9 years by Knapp, two of 5 and one of 4½ years by Nettleship; although it is true that in Brière's statistics a case of Sichel's is introduced in which a relapse was said to have occurred after nine years. Very early enucleation, as soon as the diagnosis is certain, will soon cause the number of such cases to increase. The possibility of the cure in the early stages is present from a pathologico-anatomical standpoint. That it is occasionally a matter of days is very distinctly illustrated by our case 2. Here the tumor had pressed forwards as far as the middle of the sclera through a vascular canal leading directly outwards. A complete perforation had, how-

ever, not yet taken place, and the patient, to-day, still rejoices in the best health, seven and a half years having already elapsed since the removal of the tumor.

22. It is only necessary to here call to mind the *simultaneous occurrence of two primary nodules* in the same eye in case 2, which has already been described by Becker.

ON THE CORNEAL ASTIGMATISM RESULTING FROM WEBER'S CURVILINEAR SECTION, AND ON THE CAUSES OF CORNEAL ASTIGMATISM AFTER EXTRACTIONS IN GENERAL.

BY DR. LEOPOLD WEISS.

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(With three wood-cuts.)

THERE exists a slight degree of astigmatism in every eye, almost without exception. It is to be considered as pathological, however, according to Donders, only when it exceeds $\frac{1}{40}$.*

In so far as the dioptric apparatus of the eye is composed of cornea and lens, the cause of the astigmatism may lie in either or both of these parts. While the least acuity of vision is found when the lens is the site of the astigmatism, which is generally irregular, corneal astigmatism is usually regular, and affects the sight less, in so much as a possibly greater partial curvature of the lens may correct a portion of the corneal astigmatism. Ophthalmometric measurements show that the corneal astigmatism is at times greater than that of the entire eye.†

As to the kind and direction of corneal astigmatism, it is proven that the vertical meridian is more strongly curved than the horizontal, and this agrees with the anatomical fact that

* Donders, Anomalies of Ref. and Accom.

† Donders, Anom. Ref. and Accom. Graefe's Arch., Bd. X., p. 85. "In eyes with incomplete acuity of vision, a high degree of corneal astigmatism is often found. Of 15 such eyes, in 12 it was greater than $\frac{1}{12}$." Graefe's Arch., Bd. X., p. 2.

the vertical diameter of the cornea is in every way smaller than the horizontal.*

An astigmatism of exactly an opposite direction occurs after extraction of the lens. The astigmatism must have its seat in the cornea, inasmuch as the aphakial eye presents only the refractive surfaces of this membrane.

If the incisions have been made horizontal—as is generally done—the vertical meridian will be found to have become the less refracting.

Because of these relations, diametrically opposed to general conditions, Haase concluded that the astigmatism observed after extraction must have had its origin in the operation, and further, that there was ground for the supposition that there existed a relation between the healing of the wound and the astigmatism, as the latter often changed with time; while Donders only casually remarked "that after extraction the cornea often assumes a form in which the combination with a cylindrical glass had great value." † Haase‡ first exactly determined the degree and direction of the astigmatism in a small number of aphakial eyes after the flap extraction downwards by Pagenstecher.

The result of this examination was the following:

Of six cases, the astigmatism in three was $\frac{1}{12}$; in two, $\frac{1}{6}$; and in one, $\frac{1}{11}$. While in five of these cases the astigmatism, as determined shortly after the operation, remained unchanged after the lapse of some time, it so far disappeared in one case that no benefit was obtained from a cylindrical glass three months after the operation.

As concerned the direction of the astigmatism, Haase was obliged to place the convex-cylindrical glass with its axis horizontal before the eye. If it is shown that the vertical meridian is less curved, this has either become flatter, or the horizontal more curved.

Haase maintained that the lateral curvature of the cornea

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* Donders, l. c., and Knapp, Graefe's Arch., Bd. VIII., p. 135.

† Donders, l. c.

‡ Pagenstecher, Clin. Obs. in the Augenheilanstalt of Wiesbaden, Vol. III., p. 116.

remained unchanged, but that from above downward it was lessened, "because from the interior of the eye a constant pressure was exerted upon the lips of the wound, which, though united, were still distensible, bringing about a slight bulging of the wound."

This explanation does not suffice. Further along, the causes of change of form of the cornea will be entered into more fully. Here be it mentioned, that if an intercalary tissue be placed between the borders of the wound, and bulging occurs *(both borders of the wound remaining upon the same plane)*, no flattening can take place through extension of the interposed tissue, but, on the contrary, the curvature would only be increased. On the other hand, flattening must be the result, when, as is really the case, the middle of the apposed lips of the wound is raised above the peripheral one.

Precise conceptions of the astigmatism after extraction were only obtained when the measurements of the radii of the several meridians of the cornea, both before and after the extraction, had been more closely examined. The measurements instituted by Woinow and Reuss, in a great number of cataractous eyes, both before and after extraction, prove conclusively that the astigmatism observed after extraction is an acquired one; that the vertical meridian had become markedly flatter, while the horizontal meridian retained its former curvature, or had become more curved.

These measurements exposed the fallacy of the theory, that the observed astigmatism after extraction had existed previously, but having been compensated for by the lens, only appeared after its removal.

In isolated and rare cases, this condition may come into consideration, for, as mentioned before, ophthalmometric measurements have determined that, in high degrees of corneal astigmatism, partial compensation may be offered by the lens.

As the result of the ophthalmometric measurements of Reuss and Woinow,* it is to be mentioned further, that the astigma-

* Donders, l. c., Arch. f. Ophth., Bd. X., p. 416. The measurements were made in common with Middelburg.

tism which can be computed after the radii of the curvature of the several meridians of the cornea have been determined, very closely coincides with that found with glasses. Only in rare cases should we assume the existence of retinal astigmatism.

If, on the one hand, the *kind* of astigmatism depends upon the *direction* of the incision, so, on the other, the *amount* depends on the nature of the same.

The change of form would be less in proportion, as, from the nature of the wound, the conditions of healing were favorable.

The more intimate the contact of the lips of the wound after the operation, the sooner and the more complete will be the healing, and, accordingly, all the less will the cornea suffer any change of form.

The intrinsical value of any method of operating cannot be reckoned according to the degree of astigmatism resulting from it, and the slight diminution of sight caused thereby. Therefore, exact measurements of the changes of form of the cornea after extraction have just this value, that one is justified in assuming, in the case of a slight change of form, that here the wound was of a nature favorable to exact adaptation and rapid healing, and this last is of paramount importance as to the value of a particular method of operating.

However little objection there may be to these conclusions, especially in regard to the healing of uncomplicated corneal wounds, it should nevertheless be here remarked that all the preceding observations receive a certain limitation, from the fact that the corneal wound, after extraction, is a clean one only in rare, exceptional cases; much oftener, almost always, it is complicated by participation of the neighboring tissues. It is often found by anatomical examination that wounds which externally appeared perfectly clean were really complicated (Becker's Atlas der topograph. Anatom. des Auges, I., Taf. VI. fig. 3, p. 22).*

Woinow and Reuss draw their conclusions from their ophthal-

* Upon the other side, it must be said that some portions of the subjacent tissue may be included in the wound without materially altering its adaptation, *idem*, p. 23.

mometric measurements of eyes, a number of which had been operated upon by the flap, and a number by the linear section ; that, in the former, the astigmatism, upon the whole, is greater than after the modified linear incision of Graefe, and they seek to account for it by supposing that, in Graefe's incision, the conditions, from the nature of the wounds, are more favorable to healing. Such a conclusion is to be accepted with reservation, so long as it is not known with certainty that the conditions in cases used for comparison were the same, excepting as to the difference in the form of the section. If, in any given case, the wound possess all the conditions most favorable to rapid and perfect healing, and yet it be complicated by incarceration of iris, etc., a higher grade of astigmatism will be found upon later examination than in another case, where the wound is clean and uncomplicated, though the conditions of healing *per se* were less favorable. Strictly speaking, only those cases of the several methods can be taken for comparison with one another, where there has been a clean healing of the wound. A clean, uncomplicated wound is, however, not the rule after extraction; in by far the majority the closure of the wound is complicated by participation of the neighboring tissues, and, if they are to be used for comparison, they must be arranged in groups, according to the kind and degree of the complication. Such a classification could not, however, be rigidly carried out, for, though one sought to be ever so exact, arbitrary distinctions would needs be made.

Further on, when the astigmatism resulting from the curvilinear incision of Weber shall be compared with that caused by the flap section and the modified linear incision of Graefe, we always bear in mind the before-mentioned restrictions.

In the following account of examinations of the astigmatism coming after the curvilinear incision of Weber, reference will always be made as to how the wound healed. It is only when a great number of examinations of the astigmatism due to the several methods of extraction have been made, and the manner of healing accurately noted, that, by comparing parallel cases with one another, we can legitimately conclude as to the more

favorable nature of the wound. As yet, we have no ophthalmometric measurements in cases operated upon by the curvilinear incision (of Weber or E. v. Jäger), and cannot therefore determine the consecutive astigmatism. The advantages of the curvilinear incision, after A. Weber, which unites the advantages of the incision with the lance-shaped knife with those of the linear incision, are discussed by Weber (Arch. f. Ophth., Bd. VIII.) in a very exact and lucid manner, and now the question is as to whether this decision is confirmed by ophthalmometric determinations of the changes of form of the cornea.

The conclusions of Driver, in his "Report of Fifty Cataract Operations after the Method of A. Weber" (Arch. f. Ophth., Bd. VIII., p. 2), in reference to the consecutive astigmatism after the curvilinear incision, are favorable in the extreme, and he evidently exaggerates when he says—page 200—that, "Among all the cases, after the operation, astigmatism was only found in *one*," and in this case, the operation was interrupted with prolapse of vitreous, and five months later, completed by Von Graefe's method. This is certainly incorrect. Weber himself frequently finds, a short time after his operations, an astigmatism of $\frac{1}{12}$, which, in the further course of the healing, so far diminished that, at the time of the patient's discharge from the clinic, only a slight degree remained. Dr. Rodemer, assistant to Weber's clinic, determined, at various times, the degree of astigmatism by means of cylindrical glasses, in those cases that had served me as subjects for ophthalmometric measurements.

As the result of these determinations, two things appear: in one case, the degree of astigmatism found corresponded almost exactly with that found with the ophthalmometer, and, in most cases, the astigmatism became less in degree the more time had elapsed after the operation.*

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* A few of these determinations should not be without interest in this place.

Herr J. S. R. A., operated upon August 10th, 1875.

August 22d,	with $+ \frac{1}{3\frac{1}{2}} \smile +$ cyl. $\frac{1}{16}$	axis	horizontal	$S = \frac{12}{15}$
August 27th,	with $+ \frac{1}{3\frac{1}{2}} \smile +$ cyl. $\frac{1}{30}$	axis	horizontal	$S = \frac{12}{15}$
Sept. 22d,	with $+ \frac{1}{3} \smile -$ cyl. $\frac{1}{30}$	axis	vertical	$S = 1$

L. A., operated upon August 17th, 1875.

In the winter of 1874–75, the opportunity was offered me, at the clinic of Prof. Nagel, in Tübingen, to make ophthalmometric measurements, in order to determine the astigmatism occurring after extraction by Weber's incision, Prof. Nagel having for a long time operated almost exclusively by Weber's method.

In my first examinations, I used three lights, having two of them placed near each other. In this experiment, as is known, the size of the reflected object is equal to the distance of the solitary light and the point midway between the two lights.

When it is desired to ascertain the radius of curvature in the vertical and horizontal meridians, the lights must be placed in a row horizontally, and then one above another vertically. The latter is attended with great difficulty. I omit the result of the first measurements, which, because of the difficulty mentioned, were probably not exact. It was only after I had obtained an apparatus for holding the lights that I was enabled to determine the radius of curvature of the several meridians easily and with sufficient accuracy. In three cases, which had been operated upon by Prof. Nagel and in which changes of form of the cornea resulted, examination disclosed a flattening of the vertical meridians (upward incision) while the curvature of the horizontal meridians remained almost unaltered. In one case, before the operation, the vertical meridian was, as usual, more strongly curved, and afterwards its curvature was less. In another case, the vertical meridian was, as only exceptionally occurs, of weaker curvature than the horizontal, and, through the operation, the previously existing astigmatism was increased. In the third case, though there had been prolapse of vitreous, the healing of the wound was nevertheless very favorable, and connected with very inconsiderable form-change of the cornea; perhaps it was

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August 26th, with $+\frac{1}{3\frac{1}{2}} \overset{\frown}{\smile} +$ cyl. $\frac{1}{16}$ axis horizontal $S = \frac{12}{70}$
Sept. 30th, with $+\frac{1}{3} \overset{\frown}{\smile} -$ cyl. $\frac{1}{30}$ axis vertical $S = \frac{12}{40}$

Herr D., operated upon July 25th, 1875.

August 3d, with $+\frac{1}{4} \overset{\frown}{\smile} +$ cyl. $\frac{1}{16}$ axis horizontal $S = \frac{12}{30}$
August 12th, with $+\frac{1}{4} \overset{\frown}{\smile} +$ cyl. $\frac{1}{14}$ axis horizontal $S = \frac{12}{30}$
August 20th, with $+\frac{1}{4} \overset{\frown}{\smile} +$ cyl. $\frac{1}{24}$ axis horizontal $S = \frac{12}{12}$

just here that the exact closure of the wound, occurring in Weber's incision, was of significance.

As concerns the manner of examinations, it is yet to be mentioned that to one side of the imaginary line drawn from the examined eye to the ophthalmometer, a staff was erected at a distance from the instrument corresponding to the usual size of the angle α. The examined eye was in contact with a mark drawn upon the staff at the level of the eye. Since, in most cases, cataract existed on both sides at the time of the operation, no point of fixation could be given. Such persons, however, could be directed to look towards the hand, placed so as to convey an idea of the direction in which they were desired to look.

Such an arrangement was also adopted by Reuss and Woinow. Thus it became possible to have a reflex both before and after the operation of the same central point of the cornea.

In the first of the cases herewith communicated, one eye was entirely normal. Hence a point of fixation could be given and the centre of the cornea more exactly determined.*

FIRST DETERMINATION.

Frau S., æt. 33, from Eggersheim, formerly saw both near and in the distance perfectly well with both eyes. Sept., 1874, without known cause, miscarriage. Much hemorrhage. Foggy vision. Upon admission to the clinic, in Jan., 1875, the left lens was entirely opaque. Perception of light good. Projection correct. Pupil reacted promptly when the light impinged upon it. Right eye quite healthy, $S = \frac{15}{15}$. Refraction : emmetropia. No constitutional disease discoverable. Jan. 12th, incision upwards with Weber's lance-shaped knife. The soft viscid lens came out easily. Small portions of lens matter remained behind. Healing quite normal, but little reaction. On the 24th, the eye is entirely free from irritation or redness. On this day, vision tested with the following result. With $+\frac{1}{4}$ V $\frac{15}{70}$; with $+2\frac{1}{2}$ J. No. 3 at about 6 inches.

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* Donders, Anom. of Ref. and Accom.

Before the operation, the radius of curvature in the vertical meridian was 7.26 mm.
and in the horizontal meridian it was 7.38 mm.

The posterior focal distance of the cornea in the vertical meridian ($F''v'$), calculated according to the formula $F'' = \frac{nr}{n-r}$, if $n = 1.3365$, as assumed by Helmholz, was $= 28.83$ mm., in the horizontal ($F''h$) $=$ 29.312, and the anterior focal distance in the horizontal meridian $=$ 21.932 mm. If the less refracting horizontal meridian is to be made equal to the vertical, then a convex glass must be added to it. Rays which are to be united through refraction 28.83 mm. behind the horizontal meridian of the cornea must be already convergent when they fall upon it. What the degree of convergence must be is calculated according to the formula $f' = \frac{F'h . f''}{f' - F''h}$, in which $F'h$ and $F''h$ represent the two focal distances of the horizontal meridian, f'' the distance of the image behind the refracting surface of the cornea. As observed, f'' $= 28.83$ mm., or the second focal distance of the vertical meridian. The equation for f' is hence written thus :

$$f' = \frac{F'h\, F''v}{F''v - F''h}.^{*}$$

If r'' indicates the radius in the vertical meridian, and r' that of the horizontal, then

$$F'h = \frac{r'}{n-1};\ F''h = \frac{nr'}{n-1};\ F'v = \frac{r''}{n-1};\ F''v = \frac{nr''}{n-1}.$$

Introducing these values and reducing the equations, we obtain a value for f', which is simpler to reckon, viz. :

$$f' = \frac{r''\, r'}{(n-1)\,(r''-r')}.\dagger$$

f' signifies the distance of the object from the refracting surface, or the distance of an image formed by the convex glass used.

So long as the object lies in *front* of the refracting surface, f' is positive, negative when it lies behind it, *i. e.*, when rays that impinge upon the refracting surface are so directed that, were there no such surface present, they would be united at a certain distance, corresponding to their degree of convergence, behind that plane.

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* Donders, Anom. of Refrac. and Accom.

† Compare E. Berlin, Klin. Monatsbl., 1871.

In the given case we have:

$$f' = \frac{28.83 \cdot \quad 21.932}{28.83 - 29.312}$$

$$f' = -1312 \text{ mm.} = -48.5 \text{ Paris inches.}$$

If it be required, after refraction in the horizontal meridian, that the image lie 28.83 mm. behind the cornea, the object being at a distance from the eye, rays must be rendered so convergent by a convex lens, before striking the cornea, that they would intersect at a point 1312 mm. behind the summit of the cornea. This would be attained for parallel rays by a convex glass whose focus was 1312 mm., if this glass (assumed to be very thin) lie very close to the cornea, *i. e.*, separated from the cornea by an infinitely thin layer of air. The degree of the existing corneal astigmatism would be expressed by the refractive value of the glass, which must be placed before the one meridian to make it equally refractive with the too strongly curved vertical one. Now the astigmatism which existed before the operation was $\frac{1}{48.5}$.

After the operation, the radius of curvature in the vertical meridian was $= 7.64$ mm., and in the horizontal meridian $= 7.3$ mm.

Hence may be computed:

$$F''v = 30.344 \text{ mm.}$$
$$F''h = 28.995 \quad \text{“}$$
$$F'h = 21.694 \quad \text{“}$$

The vertical meridian, which before the operation was more strongly curved, is now of lesser curvature (than the horizontal). If it be desired to make each meridian equally refractive, it may be accomplished by placing a concave glass of $\frac{1}{22.7}$ in front of the horizontal. It should be remembered that the astigmatism which now exists is the opposite of that which obtained before the operation, affecting the horizontal meridian each time, it is after the operation equal to $-\frac{1}{22.7}$, while before the operation it was equivalent to $+\frac{1}{48.5}$.

In consequence of the flattening of the vertical meridian by the operation, the pre-existing astigmatism of $\frac{1}{48.5}$ was neutralized, and further an opposite astigmatism of $\frac{1}{22.7}$ caused. The total change of curvature of the cornea is hence equal to an astigmatism of $\frac{1}{48.5} + \frac{1}{22.7} = \frac{1}{15.4}$.

SECOND DETERMINATION.

Dr. S., from Rottweil. Has not seen well with right for four years, and with the left for two years. Dr. S. formerly wore concave $\frac{1}{12}$ for distance.

R. Anterior chamber deep ; pupil responds promptly to light ; dilates sufficiently after atropine. Hypermature cataract. Perception of light good. Field of vision free. Can see Snellen No. 200 at five feet, and can read J. No. 11 at about 6″.

Jan. 12th, 1875.—Curvilinear incision, after Weber. Patient was restless during the excision of the iris, hence the iris was not cut off exactly at the angle of the wound, and a piece had afterward to be removed in the outer angle. There remained some pigment in the wound. The lens came out easily. The course of healing of the wound was good, though the eye was somewhat more injected, and for a longer time than usual. Iris drawn lightly toward the wound.

Jan 26th, with $+\frac{1}{4\frac{1}{2}}$ V. $\frac{15}{70}$ with $+\frac{1}{3\frac{1}{2}}$ J. No. 4 at about 6″. Convex cylindrical glasses—axis horizontal—improve the sight. Before the operation the radius of curvature in the vertical meridian was = 7.64 mm., in the horizontal meridian = 7.31 mm.

From which is reckoned

$$F''v = 30.344 \text{ mm.}$$
$$F''h = 29.034 \text{ “}$$
$$F'h = 21.724 \text{ “}$$

In order to render both meridians equally refractive, a concave glass of $\frac{1}{18.6}$ must be added to the horizontal meridian. After the operation the radius of curvature in the vertical meridian was = 8.4 mm.
“ “ “ “ “ horizontal “ = 7.42 “

From which is reckoned

$$F''v = 33.363 \text{ mm.}$$
$$F''h = 29.47 \text{ “}$$
$$F'h = 22.051 \text{ “}$$

Accordingly, to make the horizontal meridian equally refractive with the vertical, it must have a concave glass of $\frac{1}{6.966}$ placed before it. A pre-existing astigmatism has been increased by the operation to $\frac{1}{11.2}$.

THIRD DETERMINATION.

Mr. Burckhardt, ætat. 60, from Zoffenhausen, formerly saw near by and in the distance equally well. Has noticed failing sight for three years.

Left eye. Pupil responds to light very promptly. The reaction in the right eye is sluggish; left, perception of light good; field of vision complete. Right, false projection.

Upon the instillation of atropine, the left pupil dilated freely. Anterior chamber deep. Cataract hypermature. On the capsule are shield-shaped thickenings of a brilliantly white appearance.

Feb. 17th.—Left eye operated upon by the curvilinear incision of Weber. After excision of the iris, great difficulty was met with in opening the thickened capsule. After this was effected, masses of a thin fluid substance protruded; the cataract appeared, on account of the shrinking, to have been in part absorbed.

There was prolapse of vitreous. The shrunken cataract was extracted with Graefe's spoon. The thickened capsule remained in the eye. Upon repeated attempts to seize and draw it out, that portion grasped by the forceps tore away.

Feb. 18th.—Anterior chamber restored, the thickened capsule is drawn directly across in front of the pupil, the edges of the wound are accurately adapted. Moderate irritation.

Feb. 22d.—Eye nearly free from irritation; in the upper part of the coloboma, there is a small, dark hole through which fingers may be counted.

On the second of March, 13 days after the operation, the curvature of the cornea in the vertical and horizontal meridians was determined ophthalmometrically. The size of the corneal image was equal to 1.495 mm. in the vertical meridian, the object being 460 mm. large, and at a distance of 1,200 mm. from the reflecting surface of the cornea (1,495 mm. correspond to a rotation of the plates of the ophthalmometer of 22.1°, mean of 8 measurements. Greatest difference within the series = 1.8°). The size of the image in the horizontal meridian equalled 1.51 mm. (corresponding to a rotation of 22.26°, mean of 6 measurements. Greatest difference in any two = 1.5°).

Hence is calculated the radius of curvature for the vertical meridian = 7.8 mm., and the horizontal = 7.86 mm. Therefore both meridians

are nearly of equal curvature. A very slight degree of astigmatism exists now, while before the operation there was an astigmatism of $\frac{1}{27.3}$. According to ophthalmometric determination, the size of the corneal image in the vertical meridian *before* the operation was found to be 1.48 mm., corresponding to a rotation of 21.9° of the plates of the ophthalmometer, mean of 10 measurements. Greatest difference within the series of observations = 1.5°, if b = the size of the object = 460 mm. and a = the distance of the same 1,200 mm., we have the following formula: $r = \frac{2a\beta}{b}$ the radius of curvature in the vertical meridian = 7.6 mm. in the horizontal meridian = 7.84 mm.

From which we obtain :

$$F''v = 30.185 \text{ mm.}$$
$$F''h = 31.138 \text{ “}$$
$$F'\,h = 23.299 \text{ “}$$

Both meridians would be made equally refractive by placing a convex $\frac{1}{27.3}$ glass before the horizontal meridian ; inasmuch as the radius of curvature in both meridians after the operation was found to be approximately the same, it follows that the vertical meridian has become so much flatter that the previous astigmatism has been nearly abolished.

It will be remembered that fingers were counted with difficulty through the small rent in the coloboma, and likewise, at the time of the ophthalmometric measurements, very unsatisfactory results were obtained upon testing the vision with glasses. Since this case was complicated by prolapse of vitreous and by repeated attempts at extraction of the thickened capsule as well, and nevertheless the healing was so entirely without any irritation of importance, and followed by such slight change of form of the cornea, it is fair to assume that the result is to be attributed to the nature of the incision which offered the most favorable conditions for healing.

In part to increase the number of the measurements, and in part to compare a number of measurements at different periods of time after the operation, I determined, in the course of the summer of 1875, through the kindness of Dr. Weber, of Darmstadt, the radii of the curvature of the cornea of a number of cataract patients before and after operation.

While in the former measurements the radii of curvature were determined for the vertical and horizontal meridians in the centre of the cornea, in these measurements the determination was made from the point where the visual line passes through the cornea. To effect this, I held a small light over the telescope of the ophthalmometer and directed the person examined to look at it.

Of course, it is not impossible that the point upon the cornea from which the radii are determined may vary in the two measurements, the one before, the one after the operation, for it is conceivable that, in an aphakial eye, the visual line may cut the cornea at another point ; hence the size of the angle would be changed. But did such change occur, it would in any case be very slight, for the position of the anterior nodal point lies about 7, and the posterior nodal point about 7.4 mm. behind the cornea, and the centre of curvature of the cornea, which in aphakial eyes is the nodal point, lies at about the same place—7.3 to 7.8 mm. behind the apex of the cornea. With the purpose of ascertaining what might be the changes of α from the operation, I endeavored to determine them after the method of Donders—replacing the movable fixation-point by a small light, the movements of which may be followed with aproximate certainty by a cataractous eye.

In several measurements conducted in this way before and after the operation, I obtained no material difference in the result, but willingly admit that the method has not the degree of accuracy that could be desired. Cases of beginning cataract, in which the patient is still able to discern the point of fixation, should contribute to the solution of this question.

In one of the cases examined (Mr. O. Christ, æt. 36), the conditions for the operation were very unfavorable. In the left eye, the one to be operated upon, there existed choroidal cataract, and in the other, considerable increase of intraocular pressure. Under such unfavorable circumstances, it is not to be wondered at that well-marked astigmatism was found seventeen days after the operation. While, before the extraction, there existed an astigmatism of $\frac{1}{30}$, with the greatest curvature in the

vertical meridian ; it was found, after the operation, that the horizontal meridian was the more refractive and showed an astigmatism of $\frac{1}{11}$; the entire change of form of the cornea is therefore represented by an astigmatism of $\frac{1}{8}$.

Another patient (Mr. Schuler, æt. 60, from Pfeddersheim), operated upon in both eyes, the iris, drawn into the wound in each, had, before the operation, an astigmatism of about $\frac{1}{30}$; on the tenth day after the operation, astigmatism of $\frac{1}{12 \cdot 3}$ in the opposite meridian of the left eye was demonstrated (the corneal form-change being equivalent to an astigmatism of about $\frac{1}{9}$). Upon the right side, on the sixteenth day after the extraction, there was an astigmatism of only $\frac{1}{19 \cdot 7}$. The astigmatism, calculated from the measurements, approaches nearly to that obtained with cylindrical glasses.*

That a higher grade of astigmatism was found in the first eye measured than in the other examined, seven days later, may find its explanation in the fact that the astigmatism which exists a short time after the operation is diminished as the healing of the wound progresses. As already mentioned, *Weber* observed that a high degree of astigmatism, existing a little time after the operation, became afterwards much less.

In another case still (Herd), the conditions for operation and the healing of the wound were extremely good. The edges of the wound were accurately adapted, the iris could not be seen anywhere drawn towards the wound, the healing was entirely without reaction. Unfortunately, the circumstances of the patient were such as to render a repetition of the measurement after the operation impossible. It would not be permissible to draw general conclusions from the cases here spoken of, because of their small number, the less so as among them there were several that were complicated by implication of iris in the wound. If it be wished, with every proviso, to compare the changes of form as found after various methods, and particularly after the flap and Graefe's linear incision (in these cases,

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* In comparisons of this nature, the distance of the glass from the cornea must be taken into consideration. See above.

also, those with complications of the wound and those without are not separately considered), the determinations of Haase are next to be considered. He examined six cases after downward flap extractions, and found twice an astigmatism of $\frac{1}{6}$, once of $\frac{1}{16}$, and three times of $\frac{1}{12}$. Strictly speaking, the resulting astigmatism does not allow any conclusion as to the changes of form which the cornea suffered from the operation, for to know this it would have been necessary to examine the cornea before the operation. But inasmuch as we know that the physiological corneal astigmatism is very slight, we are warranted in assuming that the astigmatism found after operation is pretty nearly the expression of the change of form of the cornea. Of the eyes examined by Woinow and Reuss, there were eleven in which *before* and *after* Graefe's linear incision the radii of curvature in the same meridian are given.

The degree of astigmatism in these cases is as shown in the appended table on the following page.

From this table it appears that the mean change of form of the cornea is equivalent to an astigmatism of $\frac{1}{9.688}$. In almost every case the astigmatism consequent upon the curvilinear incision is less. The case which was complicated by increase of tension is an exceptional one.

If it be considered that the astigmatism resulting from the operation is determined as to its kind and degree by the direction and character of the incision, then the question for discussion is:—Wherein consists this dependence? Particularly whence comes it that, when the direction of the incision is horizontal, the vertical meridian is flatter? If we examine those eyes which have become aphakial through operation, we find anatomically that, so far as concerns the healing of the incision, there are two classes.

There is either an intercalary tissue between the apposed surfaces of the wound through its entire depth—as so excellently portrayed in Pagenstecher's Atlas (Part I., Tab. III., fig. 1) —thereby preventing exact contact of the surfaces of the wound, or an overriding of the corneal lip of the wound over the

No.	Names.	Astigmatism before operation.	Astigmatism after operation.	The form-changes of the cornea are hence equivalent to an astigmatism of
1	Misch	$-\frac{1}{35.9}$	$\frac{1}{5.99}$	$\frac{1}{5.13}$
2	Nebusky	$-\frac{1}{21.58}$	$\frac{1}{7.86}$	$\frac{1}{5.73}$
3*	Reis..........	—	$\frac{1}{8.36}$	$\frac{1}{8.36}$
4	Leiser	$-\frac{1}{72.6}$	$\frac{1}{10.72}$	$\frac{1}{9.3}$
5	Pischinger.....	$-\frac{1}{162.8}$	$\frac{1}{10.87}$	$\frac{1}{10.1}$
6	Karger........	$-\frac{1}{16.18}$	$\frac{1}{14.71}$	$\frac{1}{7.79}$
7	Braunberger...	$-\frac{1}{66.8}$	$\frac{1}{18.71}$	$\frac{1}{14.6}$
8	Pollsammer....	$-\frac{1}{111.4}$	$\frac{1}{23.01}$	Mean of the last four cases $\frac{1}{15.8}$
9*	Völker........	—	$\frac{1}{26.84}$	
10	Donabaum ...	$-\frac{1}{22.87}$	$\frac{1}{28.75}$	
11	Werhotta......	$-\frac{1}{19.27}$	$\frac{1}{66.8}$	

* In the two cases marked with an asterisk, there was no astigmatism before the operation, and it is only upon this presumption that the form-changes as given in the last column are of value; for the measurements made before and after the operation were not in the same meridian. If the same radii of curvature be found in two successive measurements of the vertical meridian, there may yet be astigmatism, since the radius of curvature may have been diminished, upon the one hand, in exact ratio to its increase upon the other.

scleral lip, as shown in vertical section by the accompanying drawing (exaggerated).

The dotted line indicates the cornea before, the dark line external to it, the cornea after the incision. Representing this condition, an exquisite picture will be found in Becker's Atlas of the Pathological Topography of the Eye, plates V. and VI.

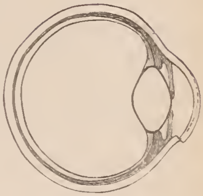

FIG. 1.

In addition to these striking changes, there are still to be added the subsequent contraction from infiltration of the neighboring tissues and the retraction of the lamellæ of the cornea—generally the most superficial—attendant upon the incision. In what sense do these several factors influence the changes of form of the cornea?

If an intercalary substance is introduced between the edges of the wound—the edges of the wound not being displaced—this substance will necessarily take part in the curvature of the meridian concerned, and, if the incision has been a horizontal one, the vertical meridian would not, as Hasse assumes, take on a weaker curvature, but the radius of curvature would necessarily be greater. The least distance between any two points is a straight line. If we imagine a cord stretched between two fixed points to represent a straight line, and then the cord being lengthened, an equal force operating upon all parts of the cord and drawing it to one side, it would assume the form of a curve. This curve would form a part of a circle the radius of which would be the shorter, the greater the length of the cord. *c o* and *c u* in fig. 2 indicate the two fixed points (in a vertical section of the cornea, the upper and lower border of the same). In *a* these two are united by a straight line, in *b* this line has become longer, and in *c* it is longer yet,

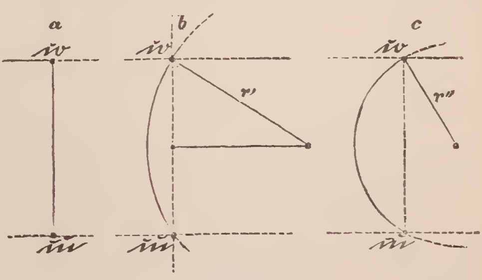

FIG. 2.

and as a consequence the radius of curvature in *c* has become

shorter. In the eye, the force which is here assumed to act equally upon all parts of the cord is the intraocular pressure, which, through the fluids of the eye, is transmitted to every portion of any given meridian. Through contraction of cicatricial tissue, and especially when this operates in the longitudinal direction, the line between the two points must be shortened, and consequently the given meridian must be rendered flatter.

On the other hand, the curvature must be somewhat increased by retraction (viz., of the superficial lamellæ), through gaping of the wound.

If we have made a linear incision as it should be made, *i. e.*, an incision which would fall within the greatest circle of the supposed corneal sphere, such an incision, according to A. Weber's experiments (Arch. f. Ophth., Bd. 13, p. 211), would gape. If the length of the incision amount to less than 8 mm., the inner edges of the wound would remain in apposition (the outer ones being 1 mm. apart) under a pressure of from 40–50 mm. Hg, which is a pressure in excess of the normal.

With retraction of the superficial lamellæ of the cornea, the thickness of the cornea in the vicinity of the wound must be increased. Generally the inner and outer surfaces of the cornea are parallel, but should the cornea become thicker at one point than at another, then this would no longer be the case. If the curvature of the inner surface has remained the same, which may be assumed as practically true, since the inner edges of the wound are not separated, then the outer surface would seem to be curved upon a shorter radius. When it is found—as with rare exceptions it is—that the vertical meridian is the less refractive after extraction, we may seek the cause of it in the projection of the central lip of the wound over the peripheral, as shown in fig. 1. Prof. Becker, to whom first occurred the importance of this factor in the corneal form-changes, was able to demonstrate and measure, almost without exception, this projection in a comparatively large number of cases after extraction. According to these measurements, the projection amounted to 0.12–0.15 mm., in the maximum 0.3 mm., in eyes

operated upon by Graefe's modified linear incision.* Does this projection explain the astigmatism generally observed?

From the succeeding observations, we shall be enabled to compute the flattening of the vertical meridian occasioned by the projection of the lip of the wound and the astigmatism dependent upon it, and to show that this astigmatism corresponds completely to that generally found.

The cornea may be assumed to have the form of a sphere. The direction of the projection of the lip of the wound is determined by the direction of the canal of the incision.

The linear incision, it is true, does not fall within the greatest circumference of the supposed corneal sphere. Yet it may be assumed that the projection occurs in the direction of a radius drawn from the centre of curvature towards the point of the incision. Further on we shall maintain that the flattening which does occur is equally participated in by the entire meridian. Before the operation, the vertical meridian represents an arc of a circle, the chord of which is equivalent to about 10 mm. The radius of curvature is 7.7 mm.

If we indicate the central angle of the arc before mentioned, by φ, the length of the arc of the circle is computed as $= 2R\pi \cdot \frac{\varphi^\circ}{360^\circ}$, since the length of the entire periphery is $= 2R\pi$.

The angle φ° is unknown to me, yet I know that

sine $\frac{\varphi}{2}$ is $= \frac{s}{2R}$, if s denotes the length of the cord.

Hence in the given case

$$\frac{s}{2R} = \frac{5}{7.7} = \text{sine}\,\frac{\varphi}{2}$$

$$\varphi^\circ = 80^\circ\ 59'\ 6''.$$

The length of the arc of the circle (P) is hence thus expressed,

$$P = 2R\pi \cdot \frac{\varphi^\circ}{360^\circ} = \frac{7.7 \cdot 3.14 \cdot 80^\circ\ 59'\ 6''}{180^\circ.}$$

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* O. Becker, Pathologie und Therapie des Linsensystems, p. 541, in Graefe-Saemisch's Cyclopedia.

$P = 10.8834$ mm.

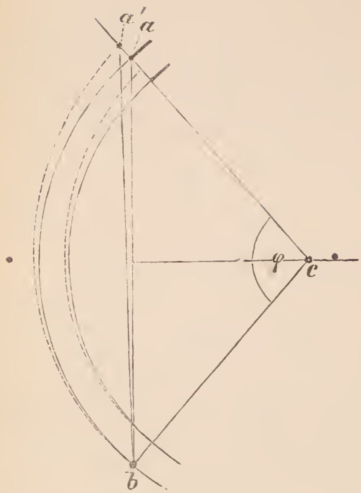

FIG. 3.

If we denote by *a* and *b* two points upon the corneal margin in the vertical meridian above and below, and unite these two points by a straight line, this line represents the chord of the arc of the cornea, whose length has been assumed to be 10 mm. Should a linear incision now be made at the upper corneal margin —falling approximately into one of the greatest circles—the corneal lip of the wound, after its completion, will project beyond that of the periphery, the point *a* will be displaced to *a′*, the extent of the displacement, however, always represents only a *fraction* of the thickness of the cornea, so that the two surfaces of the wound are for the greater part in contact, even though, as to individual portions of each, there is some displacement.

If we now draw a straight line from the point *b* to the point *a′*, this line *a′ b* will represent the new chord over which the same length of the arc is stretched, which was formerly stretched over the shorter chord *ab*.

The length of the arc which extends from *a* to *b*, and from *a′* to *b* is the same. (The slight retraction which occurs after the completion of the incision is not here considered.)

Now the arc of the circle must be bent upon a radius, proportional to the length of the chord. Given the extent of the projection *aa′*, and also the direction of the projection, and *ab*, I am enabled to compute *a′b*.

$$a'b^2 = aa'^2 + ab^2 - 2aa' \,.\, ab \,.\, \text{cosine } a'ab$$

$$\sphericalangle\, a'ab = 90° + \frac{\varphi°}{2}.$$

$$\text{cosine}\left(90^\circ + \frac{\varphi^\circ}{2}\right) = -\text{sine}\,\frac{\varphi^\circ}{2}.$$

From the preceding we have

$$a'b^2 = aa'^2 + ab^2 + 2aa' \,.\, ab.\ \text{sine}\,\frac{\varphi^\circ}{2}.$$

If we substitute the value 0.12 for aa′ we get the following

$$a'b^2 = 0.12^2 + 10^2 + 2 \,.\, 0{,}12 \,.\, 10 \,.\, \text{sine}\,\frac{\varphi^\circ}{2}.$$

$$a'b = 10.078 \text{ mm.}$$

The entire periphery of the circle of which a′b represents an arc with the chord a′b = 10.078, is $= 2R'\pi$; the length of the arc of the circle $(P') = \dfrac{2R'\pi\ \varphi.'^\circ}{360^\circ}$. [1]

φ' denotes the central angle in the new circle. R′ its radius of curvature. Between the two unknown quantities there exists the relation sine $\dfrac{\varphi'}{2} = \dfrac{s'}{2\,R'}$, in which s' denotes the new chord.

Instead of this, if the angle is not expressed in degrees, but in the length of the arc belonging to it, may be written,

$$\text{sine}\,\frac{\psi}{2} = \frac{s'}{2R'}. \qquad [2]$$

Here

$$\psi = \frac{\varphi'\pi}{180},$$

and hence from (1) we have

$$P' = R'\psi. \qquad [3]$$

Having introduced in (2) the value of R′ in (3), we obtain

$$\text{sine}\,\frac{\psi}{2} = \frac{\psi}{2} \,.\, \frac{s'}{P'}.$$

writing $\dfrac{\psi}{2} = x$, we obtain

$$x \,.\, \frac{s'}{P'} = \text{sine}\ x \qquad [4]$$

or

$$x \,.\, \frac{s'}{P'} - \text{sine}\ x = 0.$$

The solution of equations of this kind is not without difficulty. The only possibility by which one may arrive at a solution consists in establishing methodically, one after another, values for x, which shall satisfy the equation. For the following more exact solution I am indebted to the friendly assistance of Prof. Fuchs.

An approximative value for sine x is $\frac{x \cdot (60 - 7x^2)}{60 + 3x^2}$.

Introducing this, the equation (4) assumes this form

$$x \cdot \frac{s'}{P'} = \frac{x\,(60-7x^2)}{60 + 3x^2}$$

or:

$$\frac{s'}{P'}\,(60 + 3x^2) = 60 - 7x^2.$$

If the value of x as found in the equation (4) were established, the equation would not be completely satisfied. The value found for x is only an approximative value.

Completing the computation, this difference is obtained

$$\frac{s'}{P'} \cdot x - \text{sine}\,x = \varepsilon,$$

and not exactly naught.

In order to more nearly obtain the true value, we must make use of a sign of correction $\delta = \frac{-\varepsilon}{a - \text{cosine}\,x}$, if $a = \frac{s'}{P'}$.

If we insert this x as here corrected, the equation (4) would perhaps not even then be satisfied, and in the end a second and a third sign of correction would be necessary. If in the first case it be applied, where $aa' = 0.12$ mm., the result is the following:

$$s' = 10.078$$

and

$$P' = 10.8834$$
$$0.92602 \cdot x = \text{sine}\,x$$

or

$$0.92602\,(60 + 3\,x^2) = 60 - 7\,x^2$$
$$x = 0.67376.$$

From the equation (3)

$$P' = R' \psi$$

$$R' = \frac{P'}{\psi} = \frac{P'}{2x}$$

$$R' = 8.07664.$$

If the ascertained value of x be introduced into the equation $0.926\ x - \text{sine}\ x = 0$, the equation would still be unsatisfied. x is given in the size of the arc; to express it in degrees we multiply x by 180°, and divide by π, the values 0.673.76 – 38° 36′

$$0.926 \ . \ 0.67376 - \text{sine}\ 38° \ 36' = \varepsilon$$
$$0.62392 - 0.62388 = 0.00004$$

now correspond.

The sign of correction δ is therefore

$$\delta = \frac{-\ \varepsilon}{a - \text{cosine}\ x}$$

$$\delta = \frac{-\ 0.00004}{0.92602 - 0.78152}$$

$$\delta = -\ 0.000277.$$

x has been found

$$\begin{array}{rrr} & = & 0.673760 \\ \delta & = & \underline{-\ 0.000277} \\ \text{the corrected } x = x' & = & 0.673483. \end{array}$$

The second sign of correction is computed as the first, if x' is substituted.

$0.92602\ x' - \text{sine}\ x'$ should $= 0$. x' expressed in degrees should $= 38° \ 35' \ 14''$

$$0.92602\ x = 0.62366$$
$$\text{sine}\ x = \underline{0.62366}$$
$$-\quad -$$

and the equation is in fact satisfied.

With the aid of the corrected x, the magnitude of the radius eq. (3) is computed.

$$R_{''} = 8.0798.$$

The correctness of the value thus attained is susceptible of proof. The entire periphery of the circle described by $R_{''}$

amounts to $2\,R_{/\!/}\,\pi$. The arc of this circle is given me, the chord of which is equivalent to 10.078 mm., and the length of the arc is to 10.88334 mm. The length of the arc is to the entire periphery as the central angle of P′ is to 360°. Therefore,

$$\frac{P'}{2\,R_{/\!/}\pi} = \frac{\varphi'}{360^\circ}.$$

The central angle φ' I know, since the half of the chord of the radius is equal to the sine of half the central angle.

$$\varphi' = 77.175^\circ$$

$$P' \quad \frac{R_{/\!/}\,\pi\varphi'}{180}$$

$$P' = \frac{8.0798 \,.\, 3.14 \,.\, 77.175^\circ}{180^\circ}$$

$$P' = 10.8834,$$

which agrees with the proposition.

If the vertical and horizontal meridians were equally curved before the operation, there exists now a flattening of the horizontal meridians, as a sequence of the operation with a certain degree of astigmatism, the quantity of which is expressed by the refractive value of a cylindrical glass, which renders both meridians equally refractive. For the horizontal meridian

$$F''h = 30.582$$
$$F'h = 22.883\,;$$

for the vertical

$$F''v = 32.091$$
$$F'v = 24.012.$$

According to the formula

$$f' = \frac{F''h \,.\, F'v}{F''h - F''v}$$

we therefore have the computation:

$$= \frac{30.582 \,.\, 24.012}{-\ 1.509}$$

$$f' = -\ 486.64 \text{ mm.}$$

$$486.64 \text{ mm.} = 17.98 \text{ inches.}$$

A convex cylindrical glass $\frac{1}{17.98}$, axis horizontal, renders both

meridians equal. If the distance of the glass from the cornea is taken into account $\frac{1}{17.98}$ is made $\frac{1}{18.5}$ or $\frac{1}{18.75}$, according as the glass is held $\frac{1}{2}$ or $\frac{3}{4}$ inches from the cornea.

If the projection of one of the lips of the wound to the extent of 0.15 mm. is made the basis of the computation, the new chord would be thus calculated as = 10.0975 mm.

$$\frac{5''}{P} = 0.927797.$$

We have the equation

$$0.9277797\,(60 + 3x^2) = 60 - 7x^2$$
$$x = 0.66554.$$

The value ascertained for x:

$$\frac{5''}{P}\,x - \text{sine } x = 0$$

satisfies the equation up to the fifth decimal point, therefore it does not appear that a sign of correction is necessary.

According to the ascertained x, the new radius of curvature is calculated at 8.1775 mm.

Because of flattening in the vertical meridian, there is an astigmatism of $\frac{1}{14.47}$ or, if the distance of the convex cylindrical glass from the cornea be assumed to be $\frac{1}{2}''$, the astigmatism will be $\frac{1}{15.0}$.

Prof. Becker found the maximum value of the projection of one of the lips of the wound to be 0.3 mm.

At what rate is the form-change computed in this case? The new chord = 10.197

$$x = 0.62102$$
$$R = 8.7626$$

the first sign of correction = 0.0008104 the corrected x therefore = 0.620939.

Taking the corrected a as a basis, the radius of curvature is calculated at 8.7638; the astigmatism which has been produced is, therefore, equal to $\frac{1}{6.964}$.

The astigmatism thus computed corresponds to that usually found with glasses in kind and degree ; but it must be again remarked here that the entire calculation can only claim to be approximately correct, inasmuch as that in the prosecution of the computations the assumptions are only approximately true. Besides a lessening of the radius of curvature in the vertical meridian, it was many times found that there was an increase of the radius of curvature in the horizontal, though this increase was in part inconsiderable. In the same sense, as through flattening in the vertical meridian, the form of the cornea will be changed.

Ophthalmometric measurements of the breadth of the cornea before and after the operation (after the method of Donders), in several cases, afforded somewhat lesser values after the operation, yet upon the one side this difference was very slight, and upon the other side, the determination before the operation was rendered more difficult, because in the cataractous eye a small light had to be used as a point of fixation.

Therefore I hold that at present the conclusion is by no means justified : that the increase of curvature is dependent upon the diminution of the diameter, which would be quite conceivable.

As concerns the manifold changes observed a short time after operation, in the astigmatism resulting from it, it will assist in understanding them to consider that there are several factors concerned in the form-changes of the cornea which do not all act alike. Thus, a projection of one of the lips of the wound beyond the other, which was in the beginning very considerable, might in the course of the healing be rendered much less by a contraction in the wounds, which would tend to draw the projecting lip toward the level of the other.

Dr. Röder, in the last congress at Heidelberg, called attention to another consideration which might here come into play. It is that of the tension of the capsule. If the epithelial cells of the capsule proliferate after extraction, the product of this cell-proliferation will share the fate of capsular cataract in general. It shrinks when it has attained a certain growth. With this

shrinking a traction will be exercised, and the direction in which this traction is most apt to be apparent will depend upon the position and nature of the capsular cataract, the manner of opening the capsule, its subsequent adhesions, etc. A traction which is most considerable in the direction of the vertical diameter must occasion an increase of curvature in this direction, whereby a flattening which has existed might be lessened or entirely removed.

For a long time after I had finished these experiments,* I hoped that I would be enabled to increase their number. But as it is not probable that I shall have an opportunity of observing additional cases in the near future, I have concluded not to defer their publication any longer, hoping that this publication would furnish the incentive to similar labors on the part of others.

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* This will explain why the old designation is used for glasses—*vide* Brief Report in the proceedings of the Heidelberg Congress, 1875.

A CASE OF CHOROIDITIS EXSUDATIVA, ACCOMPANIED WITH PARTIAL MICROPSIA, METAMORPHOPSIA, AND CHROMATOPSIC SCOTOMATA OF SINGULARLY REGULAR FORMS.

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Miss F. L., a highly intelligent and cultivated lady of 35 years, consulted me for the first time on the 5th of Sept., 1876. She represented that her eye trouble had been first observed by her about two months previously. For some days she had noted one or two dark spots before the right eye, but one afternoon, after having been engaged in ironing continuously for some time on some fine articles which required close attention, the central spot became brilliantly colored, and its outlines assumed those of a perfect hexagon. Concentric with this hexagon were two other inner hexagons, separated distinctly from each other. Each of these individual figures displayed the colors of the spectrum, beginning with the red at the periphery, and ending on the inner edge with the violet. During the night following, the brilliancy of these colors was such as to disturb her rest materially. She, however, suffered no pain worthy of mention.

In the course of the next few days, this figure gradually assumed another form—that of a four-petalled flower, which soon became scolloped around the edges in a remarkably regular manner. This figure was situated on a dark background, which had the form of the hexagon just mentioned, with its corners somewhat rounded. There were likewise three of these figures concentrically arranged, and the order of colors was the same as in the hexagon. The intensity of the colors, however, was somewhat lessened, except at the scolloped edges, where it was very brilliant indeed. Gradually, this figure took the form of a perfect Latin cross, which in time rounded off at the ends and broke up in the middle. The colors had, by this time, become dull and

no longer followed any regular order. Subsequently, the scotomata grew more irregular.

The above description was aided by figures drawn by the patient herself, who is an artist, and may be considered as representing as accurately as is possible the outlines of the scotomata as they appeared to her.

The scotoma, when projected on a wall 20 ft. distant, was about 12 inches in diameter, and was situated a little above the point of fixation. In addition, she noticed, sometime after the appearance of the scotoma, that objects and especially straight lines appeared distorted. When looking at the face of an individual, for example, the eyebrows would appear to run sharply downward at the nose, and the palpebral aperture to run sharply upward, so as to almost meet.

At the time I first saw her, the scotoma had the appearance of a cross, the right side of which was covered by a crescent. Vision was not materially impaired, as with $-$ 1 D ($\frac{1}{36}$) she read S. XX. at 20 feet, and also read J. 1 at 12 inches, though the eye became easily fatigued and irritated under the attempt to use it. The distortions of the printed lines of the page, too, were a source of great annoyance. The lines were wavy in appearance, and seemed to converge toward a point a little above the fixation point, and the letters at this point, or in its immediate vicinity, were about one-third smaller than those more peripherally situated. This distortion extended over the space of 4 lines of J. No. 4, held at 12 inches (30 cm.) from the eye. Just at the very centre of this space, there was a dense scotoma covering the extent of two or three letters.

The ophthalmoscope showed all the media to be clear ; the disc of a more pinkish hue than normal, with an unusual number of small vessels on its surface ; the veins tortuous. At the lower and inner quadrant, and at about 3 disc diameters from the disc, was a deposit of pigment of the size of the diameter of a medium retinal vein, and about midway between this and the macula lutea was another of approximately the same size.

The most marked changes, however, were observed in the immediate vicinity of the macula itself. Here there was a very considerable derangement of the choroidal pigment. A little below the macula, the pigment was massed together, and surrounded by a reddish zone—the congested stroma of the choroid denuded of its epithelial covering.

This disturbance in the pigment extended over a space about one-third the size of the optic disc.

The left eye was amblyopic ($V=\frac{20}{200}$) and deviated outward. This amblyopia had existed, she said, all her life, and as there had never been any disease in that eye as far back as she can remember, she looked upon it as being congenital. This view is further supported by the fact that a sister, an aunt, and two cousins have likewise an amblyopia in the same eye, also congenital. In none of these, however, is there any strabismus. The changes in the fundus of this eye (and there were none observable elsewhere) were : a marked diminution in the calibre and number of retinal vessels as compared with the other eye, and a grayish-blue atrophy of the central portion of the optic disc. A narrow rim at the periphery of the disc retained its normal pink color.

Her general health has always been fair, and at the time of the commencement of the present trouble she noted nothing specially abnormal in her condition. The menstrual function has been always regular. Such is the character and standing of the individual that there could be no suspicion of syphilis, and besides, the closest inquiry failed to bring out any facts leading to such a view.

Under the use of a mercurial course, together with protection of the eyes by smoked glasses, the symptoms gradually subsided, so that by the first of November the micropsia and metamorphopsia had almost entirely disappeared and the scotoma was only seen when called up by exposure to a strong light. I have since learned, by letter (Feb. 2d), that all these symptoms have wholly subsided.

It may be mentioned, in conclusion, that there were small scotomata corresponding to the points of pigment observed in the other parts of the fundus, but they were so peripherally situated as to occasion no annoyance.

REMARKS.

The foregoing case is of interest from several points of view.

In the first place, the *choroiditis exsudativa* is, so far as we are able to learn, strictly *idiopathic*. None of the causes which we generally find in operation to produce this pathological condition, such as syphilis, etc., were present. There was not even a derangement of the menstrual function, a condition which

might, through disturbance of the equipoise of the circulation, cause an extravasation of blood or other fluid under the retina or into the stroma of the choroid, and thus give rise to the phenomena we have noted.

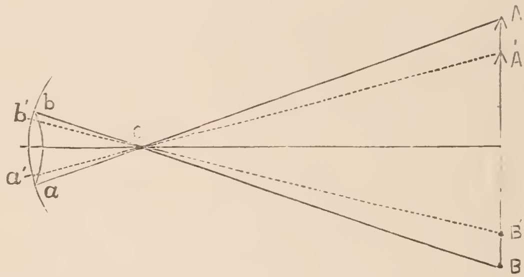
The *micropsia* and *metamorphopsia*, though not exceedingly rare conditions as accompaniments of exudations under the retina, are yet not sufficiently common to be passed by without some consideration.

It is known that Förster (*Oph. Beiträge*, 1862) was the first to investigate closely the subject of metamorphopsia attendant upon changes in the choroid or retina, whereby the percipient elements of the retina are displaced from their normal positions. These investigations, however, were confined, for the most part, to those cases where there had been a *crowding together* of the elements through contraction; those instances where the elements were subject to *separation* receiving only brief mention. The cases of Mooren, too, from the short account he has given of them (*Oph. Beobachtungen*, 1867), depended upon cicatricial contraction of the choroid, and with it the retina. Knapp also mentions (*Zehend. Monatsbl.*, II., p. 307) that the majority of cases, that had up to that time come under his observation, were dependent upon partial choroidal atrophy, and consequently, we take it, upon contraction and *crowding* of the retinal elements. In the first number of these ARCHIVES, however, he communicates a case, in a study of choroidal ruptures, where the contraction had the opposite effect, and the elements were drawn asunder. Prof. Becker, in the same number, records a micropsia and metamorphopsia from dissociation of the retinal elements, caused by a circumscribed extravasation of liquid under the retina in retinitis leucemica. And in a later work, Förster himself (*A. für Oph.*, XX., Ab. 1) reports several cases which he has observed in connection with syphilitic choroiditis, where the retinal elements were separated by an exudation underneath them.

The manner in which metamorphopsia, macropsia, and micropsia are produced by the dislocation of the retinal elements finds a ready explanation in the empiristic theory of

vision. Knapp, in the paper last referred to (ARCHIVES OF OPH. AND OTOLOGY, vol. I., No. 1), considers its mechanism in the case of contraction and separation; and Kaiser (*Archiv für Oph.* XIX. 2) gives an exposition of the theory in its application to both micropsia and macropsia; and in contradistinction to these conditions, as they are sometimes found in paresis or paralysis of the ocular muscles, more especially the muscle of accommodation, he suggests the name of *partial metamorphopsia* (micropsia and macropsia) for the instances like those under discussion, where the producing cause lies in the shifting of the retinal elements, and is limited to a restricted portion of the visual field.

A reference to the accompanying figure will at once make



clear the manner of production of micropsia in those cases, like the one we have just reported, where the retina has been pushed forward, so as to become convex on its inner surface, instead of being concave, as it is when in its normal position. The image of the object AB is formed on the elevated and stretched retina at *a b*. The retinal elements at *a* and *b* occupied normally the positions *a′ b′*, and from education have always been accustomed to project impressions received on them in the directions *a′* A′ and *b′* B′. They still project their impressions in the same manner, and as a consequence, instead of A B, we have the smaller projected image, A′ B′. The metamorphopsic appearances as denoted by the wavy appearance of the lines find their explanation in the same cause, though here, the elements being displaced irregularly, the

impressions made on them are, of course, projected in an irregular manner.

These distorted appearances should correspond, if the above theory is true, approximately at least, with the anatomical disturbances in the fundus, made manifest by the ophthalmoscope. Upon examination, we have found this to be the case. The size of the choroidal exudation, as nearly as we could estimate it, was about one-third the breadth of the optic disc. The breadth of the distorted image, when projected at 30 cm., was about 10 mm. Now, according to the known formula, $\beta = \frac{B. g''}{g'}$; in which β represents the size of the retinal image, B that of the object; g'' the distance from the nodal point of the eye to the retina; and g' the distance from the nodal point to the object. The known quantities in the equation are: B = 10 mm., $g'' = 15$ mm., $g' = 300$ mm.; therefore $\beta = \frac{10 \times 15}{300} = 0.5$ mm.

Now, if we accept the size of the o. d. as 1.56 mm., we will have the affected choroidal region about one-third the size of the disc, which corresponds very closely to the appearances shown by the ophthalmoscope.

The view that the metamorphopsic and micropsic appearances presented in this case are due to an elevation of the retina and a dissociation of its elements receives further strong support from the fact that, with the subsidence of the exudation, the elements returned to their normal positions and remain in unimpaired possession of their powers, if we are to accept as evidence of this subsidence the complete disappearance of the subjective symptoms, and the normal acuteness of vision now present. But we must bear in mind that, even after the exudation has disappeared, the healing of the choroidal disease may be attended by a *contraction with separation* of the elements again, and a return of the metamorphopsia. This secondary contraction and separation was the cause of the micropsia in the case detailed by Knapp in the first number of these ARCHIVES, and evidently was considered by Gräfe to be the cause of the same

phenomenon, in a case mentioned by him in Vol. XII., No. 2, p. 215, *A. für Oph.*, since he found it to be the "remains of the functional disturbance." It would be of interest to note the condition of vision in those cases of contraction, after the lapse of considerable time, in order to determine if the retinal elements have become adapted to their new positions, and project impressions from these instead of from the places they formerly occupied.

Simply as a contribution to the statistics of micropsia accompanying exudations under the retina, I will relate briefly a case I saw in the clinique of Abadie in Paris, in March, 1876.

It was in the person of a young man who was suspected of being affected with syphilis. With the right eye, the letters of Snellen's test types appeared to him but little more than half as large as with the left eye. Abadie at first thought it due to trouble in the accommodation, but examination proved this not to be the case. The ophthalmoscope showed marked changes in the fundus. Just below the disc there were, on either side of the principal vein, two extravasations of blood exceeding in size the diameter of the vein. At the macula, there were appearances very similar to those seen in the case reported by us. The pigment was much disturbed, and just in the centre of this disturbance there was a small triangular spot of a yellowish-red color. I much regret that circumstances prevented my making a more thorough examination of the case.

But the most remarkable feature of the case, perhaps, is the *extraordinarily regular forms which the scotoma assumed during its various changes.* It is true, we have no other evidence of this than the statement of the patient, but her high intelligence, and the fact that she described accurately the other appearances, such as the micropsia, metamorphopsia, the position of these in the visual field, etc., all of which were in strict accord with what we would expect from the opthalmoscopic appearances, leads us to accept her unprovable statement in regard to those scotomata also.

Förster, in the paper already alluded to (*Graefe's Archiv*, XX. 1), is the only author, so far as my research extends, who notices these phenomena. In his cases, as in ours, they were

accompaniments of *choroiditis exsudativa.* He says that many patients with this affection complain of subjective appearances of light of a very definite character, and that they are generally, if not always, found in the vicinity of the fixation-point. They consist of bright transparent spots, discs, circular or oval rings, and generally have a flickering, tremulous, or rolling movement. The appearances change, in some instances, from one form into another, but in none does he mention that regularity of outline which our patient delineates. In some, but not in a large proportion of cases, there was a small defect in the visual field. He also noted a circumstance which was very marked in our case, namely, an extreme impressibility to bright light—not manifested in the sense of a photophobia, but as a dazzling and confusing brightness, which was particularly disagreeable, as it called into fresh vividness the chromatopsic figures. After a walk in the bright sun-light and after an ophthalmoscopic examination, the outlines of the figures were much sharper, and the colors were much deeper in intensity. Even after these subjective sensations were no longer present under ordinary conditions, an exposure of the eye to a bright light would call them up.

As to the cause of these appearances, Förster thinks them due to an alteration in the circulation of the choroid or retina. He says: "These symptoms can, indeed, only be referred to the condition of the circulation of the choroid or retina, not to irritation of the nervous elements by an exudation or the like."

Now, whilst this explanation may be applicable to the cases which Förster reports, we think it would scarcely hold good in our case. Here the scotoma was of too regular an outline, and even in its changes followed too regular an order to depend solely on derangement in the circulation. An inspection of the figures, as drawn by our patient, showed a succession in the series of forms which could hardly be the result of changes in the condition of the circulation alone. The hexagonal figure which appeared first with such distinctness of outline serves as a background, with a gradual diminishing of its density, to all the succeeding figures, until the scotoma finally lost its

regularity of form altogether. Under either of these hypotheses, it would be difficult to understand how the resulting scotoma could be so sharply defined and regular in its outline, but it seems to me that it would be much more plausible, in view of the facts just stated, to consider it due to pressure on, and consequent irritation of, the retinal elements by the exudation. Other facts, moreover, seem to substantiate this opinion, The position of the scotoma in the visual field corresponded with the locality of the exudation in the fundus, and its estimated size bore a close relation to the estimated extent of this exudation. Her estimation of the size of the scotoma, when projected on a wall 6 metres distant, was about 30 cm. (12 inches). According to the formula previously given, the size of the retinal image $\beta = \frac{B.g''}{g'.}$. By substituting the known values in the equation we have $\beta = \frac{300 \times 15}{6000} = 0.7$. mm.

The calculated size of the retinal image of the metamorphopsia was 0.5 mm., and the estimated size of the exudation was about the same. We would naturally expect, however, that the scotoma would be somewhat larger, since a certain number of elements beyond those shifted from their proper positions would be subject to pressure.

The condition of the left eye is also not without its interest, especially when taken in connection with the family history. That five members of a family should be congenitally amblyopic in one eye can hardly be looked upon as a matter of mere incidence. We have, however, not sufficient data at hand on which to ground even a plausible speculation in regard to its etiology, but evidently some hereditary taint or predisposition must lie at the basis of it. It would be not only of great interest, but also of great clinical importance to collect all facts possible in regard to these cases of congenital amblyopia, so regarded.

NOTE.—May 29th, 1878. In a letter just received from the patient, she says that her vision has continued steadily to improve. The central scotoma is visible now only as an indistinct shadow on first waking in the morning. There is still some slight distortion of lines, and from the description and drawing she sends, I judge that the percipient elements are still separated.

DOUBLE OPTIC NEURITIS (CHOKED DISC) AND SLOUGHING OF THE RIGHT CORNEA, ACCOMPANYING A SARCOMATOUS TUMOR ON THE RIGHT SIDE OF THE BRAIN.

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There are, perhaps, no two questions in ocular pathology in a more unsettled condition than those relating to the connection between lesions of the trigeminus and inflammation of the cornea, and the manner in which optic neuritis is produced by morbid growths in the cranial cavity.

Regarding the first of these questions, diametrically opposite views have been held by parties occupying equally high positions in the world of science, and all have professed to substantiate their position by that crucial test of all scientific inquiry —experiment.

In respect to the second question, that three distinct and widely differing theories are contended for, all with a certain show of plausibility, is conclusive proof that our knowledge on that subject is yet far from definite.

Under these circumstances, the thing to be desired is a further accumulation of facts, such as can only be obtained by the clinical observation of cases, as close and accurate as possible, combined with an examination of the appearances found *post mortem.*

The following case is offered as a contribution to the study of these two questions, after this manner:

During the latter part of July, 1876, I was requested by Dr. Robert Brazelton, of New Market, Tenn., to examine, ophthalmoscopically, a case of brain trouble, in regard to the nature of which he was in some

doubt. He suspected some complication on the part of the left eye, because the patient had been complaining latterly of defective vision on that side.

The *clinical history* of the case, traced as clearly as the circumstances and condition of the patient allowed, was kindly furnished me by Dr. B., and is as follows:

Shade Peck, a negro boy of 23 years, tall, spare-made, and of previous good health, while working in the Battle Creek coal mines, in January of this year, was seized with a violent pain in the lumbar region, extending thence down the left leg. In the course of a few weeks this pain subsided, but was followed by a dull, heavy aching in the back of the head. This gradually increased in its intensity, and was finally accompanied by nausea, vomiting, epileptic attacks, marked *left* hemiplegia, and paresis of the muscles and numbness of the *right* side of the face. The bowels were constipated; appetite not materially impaired.

The treatment, instituted by the physician of the mines, was cathartics, mercury to ptyalism, and electricity.

When seen by Dr. B. for the first time, on the 16th of June, his condition was as follows: Much emaciated; intellectual faculties dull, but in no manner deranged, memory being but little affected. He complains of an excruciating pain in the *left* side of the head, which is aggravated by tapping with the ends of the fingers; muscular paresis and numbness on the *right* side of the face; tongue protruded slowly and tremulously, but quite straight; impairment of hearing and tinnitus on the right side; deglutition difficult; articulation impeded. In attempting to walk he has a tendency to fall *forward* and to the *left* side. He has every day from two to four attacks of *petit mal.* At the commencement of each of these attacks there is a nystagmatic movement of the left eye, with a strong contraction of the external rectus; frequently there is an involuntary discharge of urine and fæces. The pulse is *irregular* and intermittent. The appetite is, at times, voracious.

Though closely questioned and examined, the fact of a syphilitic taint could not be established. Treatment consisted mainly of cathartics, mercury, and potassa iodide.

An ophthalmoscopic examination revealed a swollen condition of both discs; more pronounced on the left side. The state of vision I was, on account of his stupid condition, unable to determine with any accuracy. No complaint had, however, up to this time, been made as

to the right eye. Neither could I, for the same reason, mark the diminution of hearing power on the right side. There was a paretic condition of the orbicularis of the right eye which allowed the lower and outer quarter of the cornea to be constantly exposed. At the time of my first examination, there was no trouble with the cornea or conjunctiva.

Five weeks subsequently, I was again asked by Dr. B. to see the patient on account of an ulcerative action which had recently set in on the right cornea. I saw him on a Tuesday, and learned that on the Friday previous a redness of the conjuctiva had been noticed, limited to the lower and outer portion of the globe, and corresponding to the unprotected part. The doctor saw it on Sunday, and noted at this part a slight haziness of the cornea. When I saw him, there was a sloughed condition of the cornea, embracing its lower and outer quadrant and an infiltration of tissue, extending one millimetre around it. No pain was complained of. I closed the eye with a bandage, but the sloughing process progressed in spite of this, and in a week the whole of the cornea was gone. A few days thereafter he died quietly.

A SECTIO CADAVERIS was made on the 19th of August, sixteen hours after death, by Dr. B., myself, and a medical student. Body much emaciated; *rigor mortis* well marked; right eye open, left closed. On laying open the calvarium, the membranes were found to be in a healthy condition, as was also the cerebrum. The left cerebellum seemed to be softer in consistence than the right. On the *right* side was found a *tumor* resting on the under surface of the cerebellum and extending forward on the pons varolii. It had formed a kind of nest for itself in the cerebellar substance, though it was not, strictly speaking, encysted. The surrounding brain-matter was somewhat softer than the other portions.

The tumor was triangularly pyramidal in shape, and measured at its base, on two sides, 3 centimetres, and on the other 2.4 centimetres; its height was 2.6 centimetres. From its position it exerted more or less pressure on all the cranial nerves on the right side, at their emergence from the medulla posterior to the third. The right ventricles contained about twice the usual quantity of fluid.

Both eyes were removed. On viewing the optic nerves *in situ* at their entrance into the globe, there was no appreciable distention of their sheaths, and no fluid escaped when they were severed. The eyes and the tumor were placed in Müller's fluid.

Two months after, the hardening of the tumor was completed in alcohol, and sections were made. It was found to be very vascular, the vessels varying in size from very small capillaries to those capable of being discovered by the naked eye. Its cellular element was abundant. The cells were round, had large and well-marked nuclei, and were surrounded by a thin cell-wall; many free nuclei were found scattered among the other elements. The intercellular tissue was not very abundant, and was composed of cellular-tissue fibres. At first glance, it might be mistaken for a glio-sarcoma of Virchow, but a number of examinations convinced us that the granular-like bodies were simply the nuclei of the cells which had been set free through a rupture of delicate cell-wall, from handling. We think, therefore, there can be no difficulty in classing it among the *round-cell sarcomata.*

When the eyes had become sufficiently hard to allow of sections being made, the right was examined microscopically; the posterior portion of the left being preserved as a macroscopic specimen. The optic discs were very prominent, and in the left eye the retinal veins were quite well preserved; they were tortuous, and at two places a rupture had occurred, producing an extravasation of blood of about twice the size of a retinal vein of the first magnitude. Sections through the nerve and disc showed, up to the lamina cribrosa, no appearances of pathological alteration in the nerve or its sheath.

The morbid appearances were confined wholly to the disc anterior to the lamina, and the retina in its immediate vicinity. The swollen condition of the disc was due to an increase in the quantity of connective tissue and the number of blood-vessels, scattered among which was a large quantity of small round cells. The optic-nerve fibres were not anywhere observed to be altered in their appearance from that usually seen in a normal condition; the varicosities which have some-

times been reported in similar conditions being notably absent.

Sections were also made through the anterior portion of the right globe, embracing the ciliary region, iris, and pupillary space. The pupillary space was filled with a firm substance, to the posterior surface of which and the iris, the anterior capsule of the lens adhered. No remains of the true corneal tissue was left. It is worthy of remark that the ulcerative action stopped abruptly at the scleral border, the edge of the sclerotic presenting a concavity looking outward, which would seem to substantiate the view that the sclerotic and cornea are not the same tissue modified, but distinct tissues, with probably different sources of nutrition.

Under the microscope the exudation in the pupillary space was seen to be composed of round cells closely packed together, so as, in a greater portion of the mass, to appear a homogeneous substance. On teasing, however, a number of cells were isolated which had preserved their form perfect.

The pupillary edge of the iris was not sharply defined, but merged itself into this mass, and the pigment was, in its immediate neighborhood, profusely scattered throughout the other elements of the substance. Among these cells a number of fibres were seen running longitudinally, the exact character of which was not determined. On the posterior surface of the lens-capsule, which closely adhered to the posterior surface of the iris and the substance in the pupillary space, were seen a number of epithelial cells belonging to the capsule, which were quite healthy in appearance. The tissue of the iris itself was infiltrated with round cells.

We do not propose to enter into a detailed discussion of the two questions which this case brings prominently forward. We shall simply point out those facts which it offers in support of some of the different theories advanced, respecting the pathological conditions found; and firstly those regarding *sloughing of the cornea.*

In considering the question of corneal inflammation found in connection with intracranial lesions, it would be well, we think,

not to attach too great importance to the experiment of section of the trigeminus in lower animals, and this for two reasons: 1st, Because it is not always safe to suppose the conditions of nutrition are precisely the same in animals occupying such widely different positions in the scale of existence. We are warranted in this caution by the established fact, that many remedies have not the same degree of effect in man as in the lower animals, and also by the fact which has been brought out in experiments conducted with a view to determining this very matter, that the effect of operations varies greatly, even in the different lower animals. While, therefore, we may accept the results of such experiments as throwing light upon the subject, we should not, by any means, take them as conclusive. 2d, We are not at all certain that, in cases of cerebral tumor, for instance, the lesion is confined solely to the fifth pair. In fact, most of the cases that have been reported show an involvement of other nerves in addition to the trigeminus. We should, therefore, not accept unreservedly the results of section of this nerve alone as facts on which to base a pathogenesis of the morbid condition as found in man.

As is well-known, the two principal theories on the cause of keratitis from implication of the trigeminus are, the neuro-paralytic, sustained by Schiff and his followers, and the traumatic, contended for by Snellen and others.

Looked at in the light of more recent observations and experiments, it would seem that, while neither contains the whole truth, there is a quantity in both. In the case above reported, the sensibility was not entirely lost, and the exposure to traumatic injuries was not great, since the lids could be brought almost together.

It seems highly probable, then, that it was a combination of the two causes which brought about the corneal trouble in this case. The vitality of the cornea was lowered by morbid processes at work at the root of the trigeminus, and it was thus less able to resist the traumatic influences to which it was subjected, on account of its exposure through paresis of the seventh pair.

This is Buttner's opinion, and it seems supported by observations made on other portions of the body. Dr. Mason says (Trans. Amer. Neurolog. Ass., 3d Ses., 1877): "In Dr. Brown-Séquard's laboratory I have repeatedly seen guinea pigs, whose sciatic nerves had been cut, remain indefinitely without ulcerations of the feet; but if those animals were neglected and the feet allowed to remain in filth and urine, frightful ulcerations ensued."

As regards this vaso-motor derangement (for such it evidently is), all the facts in the case reported seem to support the view of Merkel (*Graefe u. Saemisch*, Bd. 1). He maintains that the trophic branch of the fifth pair has its origin under the anterior pair of the tubercula quadrigemina, and forms the medial side of the trunk of the nerve. Meynert (*Stricker's Handbook*) had already traced one root of the trigeminus to this locality. This view is quite in harmony with the experiments of Meissner (*Zeitschr. f. rational. Med. 3d Series.* Bd. XXIV., p. 96), who found that, when the medial portion of the nerve remained undivided, no trophic changes were noticeable, but that, on section of this portion, even though the sensibility of the cornea was not affected, keratitis immediately set in. In the above case, we can readily suppose that the changes due to pressure had extended to this root, or to the fibres coming from it, and in this manner brought about a modification in the nutrition of the cornea.

On the second question—the *papillitis*, our case does not shed a great amount of light, except in so far as it shows that the theory of Schwalbe-Mainz cannot be applied to all cases. We made careful examination for distention of the optic-nerve sheaths by fluid, but in vain. Neither was the amount of fluid in the brain enough to have caused a congestion of the cavernous sinus sufficient to alone have caused the choked disc.

The objections to these two theories are so well known as to require no repetition here. In such cases, we certainly have a right to look for something more than a mere mechanical obstruction to the circulation as a cause for a proliferative inflammation confined to the surface of the optic disc. We

would naturally look, under such circumstances, for some interference in the nutrition of the part. When we have that, then those other causes—congestion of the cavernous sinus, and pressure from distention of the nerve sheath may act, like the traumatic influences in the paralyses of the fifth pair, as exciting and aggravating causes.

Provisionally, therefore, the reflex theory of Benedikt may be looked upon as the one best adapted to explain the origin of the trouble.

APRIL 5, 1878.

FURTHER TESTIMONY IN FAVOR OF THE USE OF LARGE PROBES IN THE TREATMENT OF STRICTURES OF THE NASAL DUCT.

By SAMUEL THEOBALD, M.D.,

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In a paper "On the Use of Large Probes in the Treatment of Strictures of the Nasal Duct," read before the Medical and Chirurgical Faculty of Maryland at its last annual meeting, and published in the Transactions of the Faculty for the year 1877, I have directed attention to the importance of using much larger probes than had previously been employed in the treatment of this affection, and, in support of the views expressed upon this point, have given the histories of a number of cases treated with such probes, together with the results of a series of measurements of the nasal duct, made both upon the cadaver and upon the skeleton. From which measurements it was shown, that the nasal duct, in its normal condition, has commonly a diameter of about 4¼ mm.,* and that, although the size of the canal is often much greater than this—a diameter of 7 mm. being met with in one instance—it seldom measures less than 3 mm. These measurements, it was maintained, proved conclusively the inadequate size of the lachrymal probes in common use;† rendered manifest the absurdity of expecting to

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* That is, will permit the passage of a probe of this diameter.

† No. 6, having a diameter of about 1½ mm., was the largest of the series originally recommended by Bowman. No. 8, with a diameter of about 2 mm., was the largest that had been previously in general use.

Dr. E. Williams, of Cincinnati, I have recently learned, has used for some time probes with bulbous, olive-shaped extremities, the largest which he employs having a maximum diameter (at the bulbous portion) corresponding to No. 13 of my series. With these he dilates the canal, forcibly where necessary, as a preliminary step to the

accomplish, by such means, a thorough dilatation of the canal; and indicated at least the chief cause why the method of Bowman had, in general, been attended by indifferent success.

Up to the time of the reading of this paper, I had not used in any case a probe having a greater diameter than 3 mm., but, in view of the knowledge derived from these measurements, the opinion was expressed that, in exceptional cases, it would be found of advantage to make use of one having a diameter as great as 4 mm.; and it being regarded as important that there should be established some fixed standard by which the sizes of the probes could be regulated—none having previously been recognized—a scale was proposed for adoption, as follows: No. 1, to have a diameter of $\frac{1}{4}$ mm.; No. 2, $\frac{1}{2}$ mm.; No. 3, $\frac{3}{4}$ mm.; No. 4, 1 mm.; No. 5, $1\frac{1}{4}$ mm.; No. 6, $1\frac{1}{2}$ mm.; No. 7, $1\frac{3}{4}$ mm.; No. 8, 2 mm.; No. 9, $2\frac{1}{4}$ mm.; No. 10, $2\frac{1}{2}$ mm.; No. 11, $2\frac{3}{4}$ mm.; No. 12, 3 mm.; No. 13, $3\frac{1}{4}$ mm.; No. 14, $3\frac{1}{2}$ mm.; No. 15, $3\frac{3}{4}$ mm.; No. 16, 4 mm., the diameter of each succeeding number being increased by $\frac{1}{4}$ mm., and the relation between the number and the size of each probe being such, that the number divided by four gives the diameter, expressed in millimetres.* Nos. 1, 2, and 3, it was suggested, would be found useful for exploring the canaliculi, dilating contracted puncta, etc., but were too small to be used with advantage in probing the duct; Nos. 15 and 16, it was thought, would be required in exceptional cases; Nos. 12 to 14 could be used as a rule.

During the interval between the reading of my paper and its publication, I had used, in one instance, the largest probe (No.

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introduction of a stile, the plan of treatment to which he still adheres. The bulbous extremity is unobjectionable when the probes are used simply to gain a passage for the introduction of a stile. Where, however, the probe alone is depended upon to accomplish a permanent dilatation, it is, in my opinion, far better that it should have a uniform diameter, since we then obtain, during the time it is allowed to remain in the duct, a continuous distention of every stricture which may exist; whereas, with the bulbous probe, the only portion capable of completely dilating the canal passes beyond it, and rests upon the floor of the nose in the nasal cavity.

Weber's conical probe, which fully distends only the upper portion of the duct, is still more objectionable.

* Such sets of probes, made in conformity to my instructions, may be obtained of Messrs. F. Arnold & Son, Baltimore, and of Messrs. Geo. Tiemann & Co., New York.

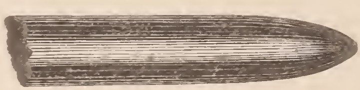
16) of the series which I had suggested, as was mentioned in a foot-note subsequently added, but I was still of opinion that it would be possible to employ a probe of this size in exceptional cases only. Further experience, however, has taught me differently, and I am now satisfied and feel quite safe in asserting that the instances in which No. 16 may *not* be used with advantage are the exceptions.

In the cases which I have treated during the past eight months, I have commonly begun the dilatation of the canal by passing No. 5, and in each it has been my aim to gradually ascend in the scale from this point, until finally No. 16 had been introduced. Of the seven cases in which I had been able to carry out this plan, including one case of a little girl seven years of age, *No. 16 has been used without difficulty in every one.* Four of these are still under treatment, the probings being repeated with No. 16, at intervals of from two to three weeks, without tendency to recontraction manifesting itself in three of them; two have been dismissed as cured, and one, the little girl referred to, has been compelled to leave the city recently, the treatment being thus temporarily interrupted. In one of the cases regarded as cured—the stricture being one of some years' standing, previously treated with only temporary benefit with smaller probes—No. 16 was introduced for the last time Oct. 28th, 1877, with great ease, four weeks having elapsed since its previous introduction. Since then the eye has remained perfectly well, there being no blennorrhœa or stillicidium; and the ease with which air could be forced through the duct a few days since, by the Valsalva method, showed it to be still freely pervious. In the other, the probe having been passed several times, at intervals of from two to four weeks, was last introduced Feb. 14th, ten weeks having elapsed since its previous introduction, when the case was dismissed as cured.

A sufficient time has not yet elapsed since I began to employ probes having a greater diameter than 3 mm., to enable me to compare satisfactorily the results obtained before and since then; nevertheless, the fact that they may be used is, I think, a conclusive argument in favor of their employment, because

it proves that, with probes of less size, the strictures are seldom completely dilated, or the normal calibre of the canal restored. That we can overcome the tendency to recontraction in all cases, and permanently cure every strictured duct which may be encountered, by the employment of a probe of 4 mm. diameter, I do not pretend to assert, since I have already met with one instance in which a rapid recontraction did occur, after No. 16 had been several times introduced;* but, in the light of recent and more extended experience, I am quite prepared to reaffirm what I have previously stated, that, "where the treatment is carried out in the manner I have indicated, probes of sufficient size being employed, and these used at first every day or two, and subsequently at longer intervals, and for some time after all inflammation has disappeared, they being allowed to remain in the duct some twenty or thirty minutes after each introduction, there are but few cases in which a permanent cure may not be accomplished."

My chief apprehension regarding the practicability of using very large probes was, that it would be found difficult to introduce them into the *sac*, through the divided canaliculus; and especially that this would be the case when the probings were repeated only at considerable intervals. Experience, however, has shown that my apprehensions were entirely groundless, no difficulty having been met with in this regard, even where a period of four or five weeks has intervened, as has been the case in several instances, between the successive introductions



Enlarged view of extremity of probe as recommended by the writer.

of the probe. In order that this may be so, however, *it is essential that the extremities of the probes should not be too blunt*, as I have previously pointed out, but should be shaped somewhat

* In this case ozæna was present, and doubtless was the cause of the nasal duct obstructions, which existed upon both sides. It is in such cases, as I have before indicated, that the prognosis is most unfavorable.

like, though more pointed than, the smaller ends of an olive or an egg, as shown in the accompanying wood-cut.

Indeed, it would be quite impossible to use the larger probes at all unless they were so formed. When, however, they are properly shaped in this particular, and are bent into the bow form which I have recommended, the introduction of even the largest of the series is not more difficult, or attended by an appreciably greater amount of pain, than the use of one of half its size.

Until I have reached the largest probe which it is proposed to use in a given case, I commonly repeat the probing every other day, generally employing one a size larger each time. Afterwards, the intervals are gradually increased, until finally a month is allowed to elapse between the successive introductions of the probe; and when several such intervals have passed without any tendency to recontraction having manifested itself, the case is dismissed as cured. During the continuance of the operative treatment, and for some time afterwards, an astringent collyrium is used, being simply dropped into the inner corner of the eye with a pipette, several times a day. A two-grain solution of alum I have found most useful, but have occasionally substituted for this, with advantage, a solution of sulphate of zinc, or of nitrate of silver, or a combination of the sulphate of zinc and alum.

In most cases, and this is a point worthy of attention, even without the aid of a nasal speculum, the extremities, especially of the larger probes, may be distinctly seen by means of reflected light in the nasal cavity, and their position in relation to the floor of the nose, etc., as certained.

I have heretofore suggested that the English urethral gum bougie might, perhaps, be employed with advantage as a substitute for the larger silver probes in dilating strictures of the nasal duct, but, as I have not succeeded in finding one with other than a comparatively clumsy, blunt extremity, which would have rendered its introduction into the lachrymal sac difficult, if not impossible, I have failed to put this suggestion to a practical test.

In due time, as I shall endeavor, so far as possible, to follow up the subsequent history of each case in which I am enabled to carry out the plan of treatment I have recommended, I hope to be able to furnish still further and more conclusive evidence in favor of the use of large probes for the cure of lachrymal obstructions.

BALTIMORE, March 22, 1878.

ON THE ETIOLOGY AND PROPHYLAXIS OF BLINDNESS.

By DR. M. LANDESBERG, Philadelphia.

My present treatise is based upon a material of 8,767 eye-patients, who came under my observation in the course of seven years. The material belongs, with some exceptions, to both the cities of Elberfeld, Barmen, and to neighboring districts of Rhineland and Westphalia. We see accordingly that this material of eye-patients is collected from very populous districts of Germany, chiefly engaged in manufacture and commerce. Of these 8,767 eye-patients, there are 580 cases of blindness, each case being counted but once. The word "blindness" is employed in a very restricted sense. Only such cases are taken into consideration here whose sight was lost without any hope of recovery. There remained excluded from the present consideration, 1st, all those cases in which the *prognosis* of amaurosis was admissible, but which still retained a certain amount of vision either at the time of first examination or discharge; 2d, such cases as were blind at the time of first examination, but whose sight was or could be restored by treatment, either entirely or in part. Thus I have omitted from consideration all cases of detachment of retina, of atrophy of optic nerve, the morbid process of which was not yet completed, although total blindness was only a question of time. Likewise have been omitted all uncomplicated cataracts (congenital as well as acquired) which admitted of a good prognosis.

The loss of material incurred by such a process of elimination is slight in comparison with the gain in correctness, which enables us to give full latitude to the purposes entertained in this treatise. It is not my intention to furnish statistical material only. I desire *to contribute to the knowledge of the causes of blindness, and to state the measures of preventing them.*

Of the questions which I endeavored to answer, I should have wished to consider those which refer to the period of blindness, and to the length of time elapsed from the beginning to the final issue of the morbid process. But I was obliged to give up this intention. As it is very difficult to obtain from the patient reliable information on these points, my records were insufficient, and did not present that accuracy which is the first condition of scientific investigation.

I classified the cases according to their etiology, dividing accordingly into single sections the numbers of the cases of blindness. To each section I added such comments and criticisms as seemed necessary. The patients I separated into men, women, and children; the latter up to their sixteenth year of age. Of married women without any trade, I stated the business of their husbands; of children without trade, the business of their fathers.

Under the head of "*Unknown Cases*" I summed up all those cases of blindness the etiology of which could neither be ascertained from the patient nor be elicited by immediate investigation, or where the inquiry after the etiology had been omitted in my diary.

Under the head of "*Final Results*" I give the description of the blind eye as I entered it in my records.

The causes of the 580 cases of blindness are:

A.—*Affections of the Conjunctiva.*

The different forms of conjunctival affections caused 48 cases of blindness, viz.:

1. *Granular conjunctivitis*, with its consecutive morbid processes, as distortion of tarsus, entropion, trichiasis, pannus, led to blindness in 26 cases, of 12 men and 14 women.

Of the men there were:

Farmers,	2	Cigar-store keeper,	1
Laborers,	3	Organ grinder,	1
In almshouse,	1	Shoemakers,	2
Hatter,	1	Retailer,	1

There were blind: of both eyes, 1 (in the almshouse); of the right eye, 4; of the left, 7.

The ages were:

From 16 to 30 years,	2	58 years old,	1
" 31 to 45 years,	8	73 years old,	1

Of the women there were:

Carpenter's daughter,	2	Plumber's daughter,	1
Factory girls,	3	Tailor's daughter,	1
Workmen's wives,	2	Servant girl,	1
Charwoman,	1	Joiner's wife,	1
Huckster's wife,	1	Farmer's daughter,	1

There were blind: of both eyes, 1 (charwoman); of the right eye, 6; of the left eye, 7.

The ages were:

From 16 to 30 years,	8	From 46 to 60 years,	3
" 31 to 45 years,	3		

Final Result:

Stump of the eyeball, in 5 cases.
Pannus, irido-choroiditis absoluta, in 3 cases (of both eyes in one case).
Pannus, phthisis of the eyeball, in 2 cases.
Total leucoma of the cornea, atrophy of the eyeball, in 4 cases.
Opaque staphyloma of the cornea, irido-choroiditis absoluta, in 6 cases.
Total leucoma of the cornea, irido-choroiditis absoluta (of both eyes in one case), in 3 cases.
Total leucoma of the cornea, sympathetic irido-choroiditis, in 3 cases.

2. *Blennorrhoic conjunctivitis* caused blindness in 6 cases, in 4 men and 2 women.

Of the men there were:

Fireman,	1	Laborer,	1
Weaver,	1	Mason,	1

The ages were:

Between 16 and 30 years,	3	41 years old,	1

There were blind: of both eyes, 1 (weaver); of the right eye, 2; of the left, 1.

Of the women, one, a servant girl, 23 years old, was blind of

both eyes; the other, a factory girl, 18 years old, of the left eye.

Final Result:

Total leucoma of the cornea, atrophy of the eyeball, in 1 case.	Phthisis of the eyeball (of both eyes in two cases) in 5 cases.

3. *Diphtheritic conjunctivitis* led to blindness of both eyes of a carpenter's child, 4 years old, through suppuration of both corneæ and consecutive panophthalmitis.

4. *The Blennorrhœa of new-born infants* led to blindness of 15 children, of whom 9 lost both eyes, 4 the right, and 2 the left eye.

The ages were:

One week,	in 1 case	Eight weeks,	in 1 case
Two weeks,	in 5 cases	Nine weeks,	in 1 "
Three weeks,	in 2 "	Five years,	in 1 "
Five weeks,	in 1 case	Eleven years,	in 1 "
Six weeks,	in 1 "	Fifteen years,	in 1 "

There were:

Workmen's children,	2	Plumber's child,	1
Tailors' children,	2	Officer's child,	1
Shopkeepers' children,	2	Farmer's child,	1
Weavers' children,	2	Laborers' children,	3
Brushmaker's child,	1		

Final Result.

Total leucoma of the cornea, buphthalmus, ciliary staphyloma (of both eyes), in 1 case.	Total leucoma of the cornea, atrophy of the eyeball, in 3 cases.
Suppuration of the cornea (of both eyes), in 6 cases.	Opaque staphyloma of the cornea, irido-choroiditis absoluta, in 1 case.
Stump of the eyeball (of both eyes in one case), in 12 cases.	Phthisis of the eyeball (of both eyes in one case), in 2 cases.

Of the affections of the conjunctiva causing blindness, granular conjunctivitis attracts first our attention. This form of disease caused blindness in more than one-half of the conjunctival cases. These great losses of vision are not attributable to the nature of the morbid process itself. The most severe forms of granular conjunctivitis admit generally of favorable prognosis, if properly treated. There must be pecu-

liar causes for such abnormal losses. The facts are as follows: In the "Wupperthal" and in the adjacent districts of Rhineland and Westphalia, where my observations have been made, the granular conjunctivitis is an endemic affection, not exempting any class of society, and spreading equally over low and high lands, over dense centres of population as well as over the country. Whether the spread of this affection is influenced by certain conditions of climate is still an open question. I was by no means able to confirm the suggestion of Mooren (Dusseldorf) that the acute granulosis is especially favored by cold, damp weather. In my district I observed this form of disease in equal frequency at all seasons.

Respecting the ages of the patients, I seldom saw children under five years suffering from granular conjunctivitis. But from this period upwards all ages are to be found, with nearly the same percentage for both sexes.

While all classes of people are nearly equally liable to granulosis, the further course of this affection is influenced by exterior circumstances to which the patients are subjected. In the wealthy classes of society, where competent medical help is called upon in the first beginnings of the affections, the granulosis always is a tractable disease. Serious consequences for the eye are hardly ever observed. In the middle classes, the sad consequences of granulosis are oftener met with, and become increased as we descend to the lower grades of society. Carelessness and impatience on the part of the sufferers are the principal causes of this state of affairs. In all the cases where the course of granular conjunctivitis is latent, medical help is sought very late. The morbid process advances but slowly, the cornea remains intact for years, and only the increasing swelling of the eyelids and a discomfort of the patient induces him to seek medical assistance. But even the advice of the attending physician is but little heeded; vision not being impaired, the patient considers his affection as very slight. The treatment is either neglected if there is any improvement, or abandondoned if, after some time, no evident result is obtained. In the mean time the patient changes his physician or

employs some domestic remedy. Thus the affection progresses: the cornea becomes involved, which, in many cases, finally results in blindness. The case does not stand much better with the acute granular conjunctivitis. As so many patients belong to the working classes, with whom suspension of work is synonymous with trouble and want, the eyes cannot be spared, the affection assumes a chronic character, ending with loss of vision in many cases, because the treatment is inadequate.

If, on the one hand, we are compelled to charge the social conditions to which the patients are subjected with the very serious consequences of a disease by no means of malignant character, we must, on the other hand, blame some methods of treatment in use *for aggravating this otherwise mild affection. I consider the method of giving to the patients or to their relatives a crayon of sulphate of copper with the advice of touching the eyelids themselves, as entirely objectionable.* Owing to the ignorance or unskilfulness of the patients, the crayon cannot be used with advantage, and often aggravates the disease. The conjunctiva of the eyelids becomes destroyed; cicatrices of the tissue are formed, giving rise to trichiasis and entropion. A method much in vogue in Rhineland against entropion and trichiasis is, in my estimation, not a small source of so many cases of granulosis ending in blindness. It is the following: *To cut out of the eyelids simply a horizontal skinflap, and to repeat this excision as often a relaxation of the citratrix reproduces the previous entropion position.* This method is very enticing to the patient, because it can be resorted to in out-door practice, and an immediate result is always certain. If the affection returns some time afterwards, the repetition of the excision is submitted to the more willingly, as the patient has experienced its favorable effect before. At last there is left no more skin for excision, and to the old affection there are added those inconveniences which are caused by lagophthalmus.

According to our statistics, we have to regard *blennorrhœa of new-born infants* as one of the most dangerous forms of disease of the eye. In the percentage of losses second to the granular conjunctivitis, this form is the first among the

affections of the conjunctiva in regard to its malignant nature. While granular conjunctivitis gives of 26 cases of blindness only 2 of both eyes, blennorrhœa of new-born infants shows of 15 cases of blindness 9 of both eyes. This great figure of losses also is not the consequence of the nature of the affection. The blennorrhœa of new-born infants is from the beginning not a malignant disease. Watched in its first symptoms, it affords a favorable prognosis and a certain cure. The principal cause of the morbid process involving such serious consequences is here also neglect and improper treatment. Slight affections of the conjunctiva, which stop either without any treatment or in consequence of a mild astringent, occur so often with babes, and the parents are so accustomed to them, that they are only regarded as a harmless affair. If the affection takes a more serious course, the midwife is ready with her advice, and the mother's anxiety is quieted, hearing similar cases cited which have been cured in a short time by the same treatment. Even in the wealthy families the family physician is rarely called in in the beginning of the disease. There, too, the midwife wields the sceptre, while in the lower classes her rule is tyrannical. It is one of the saddest experiences of the oculist when, seeing such cases ruined by criminal carelessness, he hears the old and always repeated answer: The child has been most carefully treated with warm poultices, according to the advice of the midwife, backed by the advice of good lady friends.

Of these 15 children, 3 came to me at more advanced ages, viz., 1st, a boy, 15 years old, with total leucoma of the cornea of both eyes; 2d, a girl, 5 years old, with total leucoma of the cornea and atrophy of the left eyeball; 3d, a girl, 11 years old, with stump of the right eyeball. The other children I saw between the first and ninth week of birth.

In the 8 cases of blindness of both eyes, the suppuration of the cornea was so far advanced at the time of the first examination that there were no means of checking the morbid process. In 7 cases, the previous treatment had for the most part been left to the midwife. But even where a physician was called in, no competent treatment had been employed.

In the cases of monocular blindness, the cornea of the other eye was likewise affected at the time of the first examination. In 3 cases, the vision was restored to its normal state. In a fourth case, where we had to deal with opaque staphyloma of the cornea and buphthalmus of the left eye, and with central leucoma of the cornea and anterior synechiæ of the right eye, the latter regained a certain part of vision after iridectomy.

In regard to blennorrhoic conjunctivitis, I have to say that, in the case of blindness of both eyes (weaver), the blennorrhœa has been developed from a simple conjunctivitis, through neglect and bad treatment. As the patient suffered from a slight inflammation of the conjunctiva, I prescribed a solution of sulphate of zinc; but, upon the advice of an old woman, he applied hot poultices to both eyes for several days in succession. The appearance of violent suppuration was looked upon as a salutary crisis. When I saw the patient, ten days afterwards, both corneæ were totally destroyed by the suppurative process.

The fireman, a habitual drunkard, was seized, while under my treatment for blennorrhoic conjunctivitis of both eyes, with delirium tremens. Removed to the city hospital, his left eye was lost there, in consequence of suppuration of the cornea.

The case of diphtheritic conjunctivitis was the only one I had the opportunity of seeing in the course of seven years' practice at Elberfeld, notwithstanding diphtheritic affections were not of so very rare occurrence either in Elberfeld or in the adjacent districts. The affection of the eyes was probably caused by infection. A child, five years old, of the same family, was suffering at the same time from diphtheria of the throat, and both children were kept in the same room.

B.—*The Affections of the Cornea.*

The primary affections of the cornea caused 85 cases of blindness, of 37 men, 29 women, and 19 children.

Of the men there were:

Watchman,	1	Disabled soldier,	1
Masons,	9	Farmers,	3
File-cutters,	2	Turner,	1
Shoemakers,	2	Upholsterer,	1
Smiths,	2	Saddler,	1
Bookbinder,	1	Workmen,	5
Cooper,	1	Weavers,	4
Joiners,	2	Chimney-sweeper,	1

The ages were:

From 16 to 30 years,	10	From 46 to 60 years,	9
" 31 to 45 years,	14	" 61 to 75 years,	4

There were blind: of both eyes, 3; of the right eye, 19; of the left, 15.

Of the women there were:

Workmen's widows,	6	Shoemakers' wives,	2
Servant-girls,	4	Factory women,	4
Factory girls,	8	Joiner's daughter,	1
Washerwomen,	2	Merchants' wives,	2

The ages were:

From 16 to 30 years,	11	From 46 to 60 years,	6
" 31 to 45 years,	7	" 61 to 75 years,	5

There were blind: of both eyes, 2; of the right eye, 14; of the left, 13.

Of the children there were:

Laborers' children,	4	Tailor's child,	1
Plumber's child,	1	Farmer's child,	1
Weavers' children,	4	Joiner's child,	1
Stone-cutter's child,	1	Washerwoman's child,	1
Merchants' children,	2	Shoemaker's child,	1
Designer's child,	1	Butcher's child,	1

The ages were:

From 1 to 5 years,	13	11 years old,	1
" 6 to 10 years,	5		

There were blind: of both eyes, 1; of the right eye, 10; of the left, 8.

Final Result :

Opaque pyramidal staphyloma of the cornea (of both eyes in two cases), in 10 cases.

Atrophy of the eyeball in consequence of perforation of the cornea and prolapse of iris and vitreous (of both eyes in one case), in 5 cases.

Phthisis of the eyeball, with staphyloma of the iris, in 5 cases.

Total leucoma of the cornea (with and without anterior synechiæ), irido - choroiditis absoluta (of both eyes in one case), in 14 cases.

Opaque pyramidal staphyloma of the cornea, with consecutive glaucoma, in 5 cases.

Epithelioma of the cornea, iridocyclitis, in 3 cases.

Stump of the eyeball, in 7 cases.

Total leucoma of the cornea, staphyloma of the iris, in 4 cases.

Total leucoma of the cornea, consecutive glaucoma, in 5 cases.

Total suppuration of the cornea (of both eyes in one case), in 8 cases.

Total leucoma of the cornea, atrophy of the eyeball (of both eyes in one case), in 7 cases.

Panophthalmitis, in 4 cases.

Buphthalmus, leucoma corn. adhærens, in 4 cases.

Leucoma corn. adhær., iridocyclitis chronica, consecutive glaucoma, in 3 cases.

Sclerosis corneæ, consecutive glaucoma, in 1 case.

One child, 18 months old, blind of both eyes, born of a syphilitic mother, showed all signs of hereditary syphilis. The affection of the cornea began with a small central infiltration. The resisting power of the cornea was but very slight. A diffuse suppuration soon set in, leading, in a short time, to maceration of both corneæ.

One of the three cases of epithelioma of the cornea was observed in a chimney-sweeper.

It need not be mentioned that, in these cases also, neglect and carelessness were the chief causes of blindness. Slight forms of keratitis, which, under proper care, might have been cured without any impairment of vision, had often caused the loss of the eye in consequence of neglect. The cause of the affection of the cornea was greatly influenced by the season. The spring and summer were the most unfavorable periods. In this time, the tendency of suppuration was common to all affections of the cornea. Even the slightest cases required more than usual care to avoid bad results. Such patients as workmen, stonecutters, and masons, who were obliged to continue their work

under the injurious influences of their trade, furnished the largest percentage of severe forms of keratitis, resp. of blindness.

C.—*Affections of the Uveal Tract.*

With 58 cases of blindness in 24 men and 34 women.

Of the men there were :

Baker,	1	Organ-grinders,	2
Factorymen,	4	Laborer,	1
Retired men,	2	Butchers,	2
Hotel-keeper,	1	Smiths,	3
Miner,	1	Dyer,	1
Merchants,	3	Tailor,	1
Physician,	1	Shoemaker,	1

The ages were :

From 20 to 30 years,	3	From 46 to 60 years,	6
" 31 to 45 years,	12	" 61 to 70 years,	3

There were blind : of both eyes, 2; of the right eye, 8; of the left, 14.

Of the women there were :

Merchants' wives,	3	Carpenter's daughter,	1
Servant-girls,	4	Shoemaker's daughter,	1
Workmen's widows,	4	Shoemaker's wife,	1
Monger's wife,	1	Dyers' wives,	2
Monger's daughter,	1	Locksmith's wife,	1
Merchants' widows,	2	Weavers' daughters,	3
Printer's daughter,	1	Farmer's daughter,	1
Factory women,	8		

The ages were :

From 16 to 30 years,	6	From 46 to 60 years,	16
" 31 to 45 years,	10	" 61 to 75 years,	2

There were blind : of both eyes, 3; of the right eye, 17; of the left, 14.

Final Result.

Irido-choroiditis absoluta, closure of pupil, consecutive glaucoma (of both eyes in two cases), in 8 cases.

Irido-chor. chron. with phthisis of the eyeball (of both eyes in two cases), in 9 cases.

Irido-choroiditis sympathica with consecutive glaucoma (of both eyes in one case), in 5 cases.

Irido-choroiditis absoluta, detachment of retina, atrophy of the eyeball, in 6 cases.

Irido-chor. absoluta, closure of pupil, cataracta capsularis, in 5 cases.

Irido-chor. serosa, with detachment of retina, in 6 cases.

Irido-chor. chron., with consecutive cataract and luxation of lens in the anterior chamber, in 3 cases.

Irido-chor. chron. absol., with formation of pseudo-membranes in vitreous, in 4 cases.

Irido-chor. absol., with ossification in the interior of the eyeball and phthisis of the same, in 4 cases.

Irido-cyclitis, with ossification in the interior of the eyeball, in 3 cases.

Choroiditis serosa, with detachment of retina and phthisis of the eyeball, in 5 cases.

My experience shows that the female sex is more subject to affections of the uveal tract than the male, and at an earlier age, often in the first years of puberty. The cases of consecutive blindness occur, therefore, earlier with women than with men. While, according to my records, there is no case of blindness in men prior to the 20th year of age, we have 6 cases of blindness in women between the ages of 15 to 30 years, of which 2 cases are of 17 and 19. A highly dangerous form of affection of the uveal tract is the serous irido-choroiditis, to which women of tardy or irregular menstruation are often subject, and which often returns with renewed violence, leading, at last, in many cases, to blindness by detachment of retina. The course of this affection is often very latent. In cases of monocular affection, we have frequent occasion to see the loss of vision, either total or partial, while the patient has no idea that she is affected with an eye-disease. The climacteric process of involution of women is often accompanied by morbid disturbance of the uveal tract, called "*choroiditis plastica*," the prognosis of which, however, is not unfavorable.

Of the girls, there were 4, aged respectively 17, 19, 23, and 24 years, who were laboring under amenorrhœa. Of these, 1

(17 years old) suffered with severe chlorosis, and the 3 others from congestion of the brain, complicated with neuralgia of the head. In no case was there any anomaly of the sexual organs.

Of these girls, three suffered from serous irido-choroiditis of both eyes. The result was: *loss of both eyes in two cases and one eye in one case.* The fourth girl came under my treatment with irido-choroiditis and closed pupil of both eyes. Her right eye only could be saved.

D.—*Affections of the Retina.*

14 cases of blindness were due to affections of the retina, 6 in men and 8 in women.

Of the men there were:

Three farmers, aged respectively 35, 41, 46 years.
One weaver, 36 years old.
One private gentleman, 27 years old.
One smith, 46 years old.

There were blind: of both eyes, 5; of the left eye, 1 (27 years old).

Of the women there were:

One baker's wife, 73 years old.
One merchant's wife, 68 years old.
One weaver's daughter, 16 years old.
Two school-teachers' wives, 50 and 51 years old.
One weaver's wife, 59 years old.
One letter-carrier's wife, 58 years old.
One monger's daughter, 18 years old.

There were blind: of both eyes, 2 (the letter-carrier's wife and the monger's daughter); of the right eye, 4; of the left, 2.

Final Result:

Apoplectic retinitis, in 2 cases.
Apoplexy of retina (of both eyes in one case), in 3 cases.
Neuro-retinitis, with hemorrhages of retina (of both eyes in three cases), in 5 cases.
Pigmentary retinitis, with subacute glaucoma of both eyes, in 1 case.
Pigmentary retinitis (of both eyes in two cases), in 3 cases.

The girl, 16 years old, lost her left eye in consequence of apoplectic retinitis, with consecutive atrophy of the optic nerve.

Three months previously, she suffered from severe metrorrhagia. In the mean time the eyes remained perfectly normal. Whether there was any connection between the former metrorrhagia and the subsequent apoplexy must remain an open question.

The girl, 18 years old, lost both eyes in consequence of pigmentary retinitis. She had three brothers, aged respectively 23, 28, and 35 years, and four sisters, aged respectively 14, 20, 25, and 29 years. Of these, the three brothers and two sisters were suffering, too, from typical pigmentary retinitis, with considerable concentric contraction of the field of vision, and diminution of the central power of vision.

In these cases, the result of examination was as follows:

1. The brother, 23 years old, had vision in both eyes $= \frac{15}{70}$. Read Jaeger 4. Could find his way at night.

2. The brother, 28 years old, counted fingers with the right eye at 6 feet; vision of the left eye $= \frac{15}{100}$. Read with the left eye Jaeger 14. Could not find his way at night.

3. The brother, 35 years old, vision of the right eye $= \frac{15}{200}$, of the left $= \frac{15}{70}$. Read with the right eye Jaeger 16, with the left, Jaeger 7. Could not find his way at night.

4. The sister, 25 years old. Vision of the right eye $= \frac{5}{70}$, of the left $= \frac{5}{100}$. Read with the right eye Jaeger 10, with the left, Jaeger 18. Could not find her way at night.

5. The sister, 29 years old, counted fingers at 2 feet with the right eye, and at 8 feet with the left. Could read some words of Jaeger 23 with the right eye, and of Jaeger 18 with the left. Atrophy of optic nerve of both eyes. Could even at day-time hardly find her way. Besides, the right ear was totally deaf, and the left one very hard hearing.

The older two sisters and the father had normal eyes. The mother, who died in her last childbed, was said to have been very weak-sighted. There was consanguinity among the parents.

The sister, twenty years old, had been married to her cousin for two years. Her male child, one year old, showed some small star-shaped pigment dots on the periphery of both retinæ.

Among the men, there were three who had lost their sight by pigmentary retinitis.

1. A farmer, 35 years old, blind of both eyes. There was, besides, a complication of subacute glaucoma of both eyes. The patient is the

youngest of four brothers and sisters, of whom only one sister, with normal eyes, is still living. The others died in their youth, and no satisfactory information could be obtained either respecting the condition of their eyes or of those of their parents, who, too, were dead. Consanguinity of the parents did not exist.

2. A private gentleman, 27 years old, blind of both eyes. He has two brothers, aged respectively 33 and 46 years, and one sister 21 years old. The eldest brother only is suffering from pigmentary retinitis, which affects especially the peripheric parts of the retina. There is concentric contraction of the field of vision, but still a good central vision. Jaeger 3 is read by each eye, and patient is able to find his way at night. The other brother and sister have normal eyes. The parents are dead. The father is said to have been weak-sighted. There was consanguinity of the parents.

3. A farmer, 46 years old, blind of the left eye. The right eye, suffering from highly-developed pigmentary retinitis, has a vision of $\frac{5}{200}$, and reads some words of Jaeger 16. Field of vision limited to the fixing point. Can find his way only at day-time, and only in familiar places. He is the only child of first marriage. His mother, who died in consequence of carcinoma of the womb, was weak-sighted during the latter part of her life. There was no consanguinity of the parents. The father, 68 years old, is suffering from immature cataract of the right eye, with good perception of light and good projection. His left eye has a vision of $\frac{15}{40}$, with Hm. $\frac{1}{15}$, and irregular astigmatism. Background of the eye is normal. Of a second marriage there are three children with normal eyes.

In all the cases of blindness in consequence of apoplexy and hemorrhage of the retina, there was no organic disease.

E.—*Detachment of Retina.*

This affection caused 38 cases of blindness, 30 in men and 8 in women.

Of the men there were :

Carpenter,	1	Locksmith,	1
Organ-grinder,	1	Carpenter,	1
Weavers,	3	Tailors,	2
Merchants,	3	Grave-digger,	1
Factorymen,	4	Baker,	1
Clerks,	3	Printers,	2
In almshouse,	2	Dyer,	1
House painter,	1	Bookkeeper,	1
Railroad officer,	1	Farmer,	1

There were blind: of both eyes, 6; of the right eye, 13; of the left, 11.

The ages were:

From 16 to 30 years,	5	From 46 to 60 years,	16
" 31 to 45 years,	7	" 61 to 65 years,	2

The six patients blind of both eyes were aged respectively 40, 47, 48, 59, 60, 65 years.

In two cases of blindness of both eyes, the eyes of the parents and of the brothers and sisters were examined. The result was:

In the first case:

1. Father, baker, 68 years old. M. $\frac{1}{5}$ with V. = $\frac{15}{30}$ of both eyes. Very large staphyloma posticum and some atrophic spots in choroid.
2. Mother, 65 years old. M. $\frac{1}{15}$, V. = $\frac{15}{15}$ of both eyes. Only small circumpapillar choroidal atrophy.
3. Brother, copyist, 26 years old. M. $\frac{1}{6}$, V. = $\frac{15}{40}$ of both eyes, with small staphyloma posticum and insufficiency of the interni.
4. Brother, printer, 34 years old. R. E., M. $\frac{1}{2\frac{1}{2}}$, with V. = $\frac{15}{50}$. L. E., M. $\frac{1}{6\frac{1}{2}}$, with V. = $\frac{15}{30}$. Divergent strabismus of the right eye. Highly developed staphyloma posticum and atrophy of the choroid of both eyes.

In the second case:

1. Father, farmer, 71 years old. M. $\frac{1}{8}$, V. = $\frac{15}{20}$ of both eyes. Small staphyloma posticum.
2. Mother, 67 years old, M. $\frac{1}{30}$, V. = $\frac{15}{15}$ of both eyes. Background of the eyes normal.
3. Brother, merchant, 45 years old. M. $\frac{1}{18}$, V. = $\frac{15}{20}$ of both eyes. Small staphyloma posticum. Insufficiency of the interni.
4. Brother, engraver, 32 years old. M. $\frac{1}{20}$, V. = $\frac{15}{15}$ of both eyes. Small staphyloma posticum.
5. Sister, married, 37 years old. M. $\frac{1}{18}$. V. = $\frac{15}{20}$ of both eyes. Small staphyloma posticum.
6. Sister, 28 years old. M. $\frac{1}{36}$, V. = $\frac{15}{15}$ of both eyes. Small staphyloma posticum and slight insufficiency of interni.

In the other four cases of blindness of both eyes, only the brother of one patient was examined. He was a printer, 35 years old, and had in the right eye M. $\frac{1}{15}$, with V. = $\frac{15}{40}$, and beginning detachment of retina, while in the left eye there was M. $\frac{1}{11}$, with V. = $\frac{15}{20}$, highly developed staphyloma posticum and atrophic spots in choroid.

In eight cases of *monocular blindness,* the nearest members of the family were examined.

First case.

1. Father, merchant, 59 years old. M. $\frac{1}{17}$, V. = $\frac{15}{30}$ in both eyes. Small staphyloma posticum.
2. Mother, 61 years old. M. $\frac{1}{10}$, V. = $\frac{15}{15}$ of both eyes. Small staphyloma posticum.
3. Son, merchant, 30 years old. M. $\frac{1}{24}$, V. = $\frac{15}{12}$ of both eyes. Small staphyloma posticum. Rarefaction of the choroidal epithelium.
4. Daughter, married, 35 years old. M. $\frac{1}{18}$, V. = $\frac{15}{15}$ in both eyes. Small circumpapillar atrophy of the choroid.

Second case.

1. Father, locksmith, 65 years old. M. $\frac{1}{5\frac{1}{2}}$, V. = $\frac{15}{40}$ in both eyes. Small staphyloma posticum.
2. Mother, 59 years old. E. V. = $\frac{15}{15}$ in both eyes. Background of the eye normal.
3. Daughter, married, 25 years old. R. E., M. $\frac{1}{24}$, V. = $\frac{15}{20}$. Emmetropia of the left eye, with V. = $\frac{15}{15}$. Background of the eyes normal.

Third case.

1. Father, shoemaker, 51 years old. M. $\frac{1}{10}$, V. = $\frac{15}{20}$ of both eyes. Small staphyloma posticum.
2. Mother, 56 years old. R. E., M. $\frac{1}{18}$, V. = $\frac{15}{20}$. L. E., M. $\frac{1}{4\frac{1}{2}}$, V. = $\frac{15}{30}$ of both eyes. Large staphyloma posticum. Slight divergent strabismus of the left eye.
3. Son, shoemaker, 22 years old. M. $\frac{1}{18}$, V. = $\frac{15}{20}$ in both eyes.
4. Son, tailor, 25 years old. M. $\frac{1}{9}$, V. = $\frac{15}{20}$ in both eyes.
5. Daughter, 23 years old. M. $\frac{1}{36}$, V. = $\frac{15}{15}$ in both eyes.

Very slight staphyloma posticum in the latter three cases.

Fourth case.

1. Father, workman, 63 years old. E. V. = $\frac{15}{15}$ in both eyes.
2. Son, weaver, 36 years old. M. $\frac{1}{45}$, V. = $\frac{15}{20}$ in both eyes. Small staphyloma posticum.
3. Son, weaver, 32 years old. M. $\frac{1}{9}$, V. = $\frac{15}{20}$ in both eyes. Small staphyloma posticum.

Fifth case.

1. Father, printer, 61 years old, M. $\frac{1}{6}$, V. = $\frac{15}{40}$ in both eyes Insufficiency of the interni, large staphyloma posticum, and atrophic spots of choroid.

2. Son, printer, 29 years old. M. $\frac{1}{5}$, V. = $\frac{15}{20}$ in both eyes. Large staphyloma posticum.

3. Daughter, seamstress, 26 years old. M. $\frac{1}{11}$, V. = $\frac{15}{15}$ in both eyes. Small staphyloma posticum.

Sixth case.

1. Grandfather, baker, 79 years old. M. $\frac{1}{20}$, V. = $\frac{15}{40}$ in both eyes. Small sclerectasia posterior.

2. Mother, widow, 54 years old. E. V. = $\frac{15}{15}$ in both eyes.

Seventh case.

1. Brother, barber, 44 years old. M. $\frac{1}{12}$, V. = $\frac{15}{15}$ in both eyes. Small staphyloma posticum.

2. Brother, barber, 29 years old. M. $\frac{1}{18}$, V. = $\frac{15}{15}$ in both eyes. Small staphyloma posticum.

3. Sister, shop-girl, 24 years old. Hm. $\frac{1}{36}$, V. = $\frac{15}{20}$ in both eyes.

Eighth case.

1. Sister, married, 29 years old. E. V. $\frac{15}{20}$. Maculæ corneæ of both eyes. Background of the eyes normal.

2. Sister, married, 35 years old. R. E., M. $\frac{1}{15}$, V. = $\frac{15}{15}$. L. E., Hm. $\frac{1}{36}$, V. = $\frac{15}{40}$. Background of both eyes normal.

In the other cases, there was no opportunity of examining either the parents or brothers and sisters. The statements of the patients as to the hereditary circumstances differed. In some cases, it could not be ascertained whether the parents or the brothers or sisters had been near-sighted or not. In other cases, the question as to the myopia, either of the parents or the brothers or sisters, was answered affirmatively.

The investigation as to the myopia of the patients who lost their sight in consequence of detachment of retina gave the following result:

In the six cases of detachment of retina of both eyes, there existed a doubt only in one case as to whether the patient had suffered from highly developed myopia. In all other cases, highly developed progressive myopia was established with certainty.

The twenty-four cases of monocular detachment of retina showed:

M. $\frac{1}{36}$ of the right eye, in 1 case.
M. $\frac{1}{11}$ of the right eye, in 1 case.
M. $\frac{1}{10}$ of the left eye, in 2 cases.
M. $\frac{1}{8}$ of the left eye, in 1 case.
M. $\frac{1}{7}$ of the right and left eye, in 2 cases.
M. $\frac{1}{6\frac{1}{2}}$ of the right eye, in 2 cases.
M. $\frac{1}{5}$ twice of the right and once of the left eye, in 3 cases.
M. $\frac{1}{4}$ three times of the right eye, and twice of the left eye, in 5 cases.
M. $\frac{1}{3\frac{1}{2}}$ of the left eye, in 3 cases.
M. $\frac{1}{3}$ of the right eye, in 2 cases.
M. $\frac{1}{2\frac{1}{2}}$ of the left eye, in 1 case.
M. $\frac{1}{2}$ of the right eye, in 1 case.

Among the women there were:

Weavers' wives,	3	Baker's wife,	1
Dealer's widow,	1	Tiler's wife,	1
Merchant's wife,	1	Washer-woman,	1

Their ages were:

29 years,	1	From 61 to 75 years,	2
From 45 to 60 years,	5		

There were blind: of both eyes, 2 (53 and 60 years old); of the right eye, 1; of the left, 5.

In the cases of monocular blindness, the refraction of the other eye showed:

M. $\frac{1}{8}$ in 2 cases.
M. $\frac{1}{5}$ in 1 case.
M. $\frac{1}{4}$ in 2 cases.

Of one case the myopia could not be ascertained. The eye was suffering from cataract, and the statements of the woman were inaccurate.

In both cases of detachment of retina of both eyes, the pre-existence of highly developed myopia could be established with certainty.

The investigation as to the hereditary circumstances gave the following result:

In the two cases of detachment of retina of both eyes, the patients stated that their father was very near-sighted. As to the mother, the answer was affirmative in one case and remained doubtful in the other. In the latter case, as an example of superior power of vision of the family, the grandmother was spoken of as having been able to perform the finest needle-work in her old age without glasses. Here, too, there existed

hereditary predisposition. One patient told us that her brother lost both eyes at the age of 35 years.

In the six cases of monocular detachment of retina, the examination of the nearest members of the family yielded the following result :

First case.

1. Mother, farmer's widow, 56 years old. M. $\frac{1}{24}$, V. = $\frac{15}{20}$. Small sclerectasia posterior of both eyes.

2. Brother, locksmith, 35 years old. R. E., M. $\frac{1}{9}$; L. E., M. $\frac{1}{12}$. V. = $\frac{15}{20}$ of both eyes. Small sclerectasia posterior and insufficiency of the interni.

Second case.

1. Brother, copyist, 47 years old. M. $\frac{1}{6\frac{1}{2}}$, V. = $\frac{15}{40}$ of both eyes. Sclerectasia posterior and atrophy of the choroid.

2. Sister, married, 17 years old. M. $\frac{1}{9}$, V. = $\frac{15}{20}$ of both eyes. Small staphyloma posticum.

Third case.

1. Brother, 9 years old. Hm. $\frac{1}{36}$, V. = $\frac{15}{20}$ of both eyes.

2. Sister, seamstress, 30 years old. R. E., M. $\frac{1}{9}$, V. = $\frac{15}{20}$; L. E., M. $\frac{1}{6}$, V. = $\frac{15}{40}$. Convergent strabismus of the left eye. Small sclerectasia posterior of both eyes.

Of the fourth and fifth cases the hereditary tendency remained undecided. The parents were dead and had had no other children.

In the sixth case, the patient assured most emphatically that in both families, both on the father's and mother's side, nearsightedness had prevailed.

Final Result.

Detachment of retina, consecutive cataract (of both eyes in two cases), in 11 cases.

Detachment of retina, atrophy of the eyeball, in 1 case.

Detachment of retina, opacities of vitreous (of both eyes in six cases), in 25 cases.

Detachment of retina, phthisis of the eyeball, in 1 case.

F.—*Affections of the Optic Nerve.*

46 cases of blindness. Of these affections we have two categories :

a. The genuine atrophy of the optic nerve, with 28 cases of blindness: 24 in men, and 4 in women.

Of the men there were:

Shoemaker, ...	1	Blacksmiths, ...	4
Weavers, ...	7	Firemen, ...	2
Merchants, ...	2	Cabinetmaker, . . .	1
Locksmiths, ...	3	Tailor, ...	1
Plumber, ...	1	Inn-keepers, ...	2

There were blind: of both eyes, 20; of the right eye, 2; of the left, 2.

Their ages were:

From 25 to 30 years, . .	2	From 46 to 60 years, . .	8
" 31 to 45 years, . .	14		

In the four cases of monocular blindness, the other eye, too, was suffering from atrophy of the optic nerve. In the two cases of blindness of the right eye, aged respectively 39 and 47 years, the vision of the left eye was $\frac{6}{7}$ and $\frac{15}{70}$. In the two cases of blindness of the left eye, aged respectively 28 and 41 years, the vision of the right eye was $\frac{15}{200}$ and $\frac{15}{50}$.

As to the etiology of atrophy, *excessive indulgence in alcoholic stimulants and tobacco* was proved to be the cause in the cases of three locksmiths, four blacksmiths, two inn-keepers, two firemen, and one merchant.

Suspicion of abuse of alcoholic liquors and of tobacco existed in the cases of one cabinetmaker, one merchant, and two weavers.

The inquiry into the other eight cases yielded no information.

I never had an opportunity of observing cases of genuine amblyopia or amaurosis caused by the exclusive abuse either of liquor or tobacco. In all cases, without exception, both agents were the cause of the affection. In regard to the anamnesis we must be very careful. We seldom obtain a direct confession that alcoholic liquors have been immoderately indulged in. In general, the ideas of such patients in regard to *immoderate use* are very vague. Habitual drunkards most earnestly

assert that they take daily a drink of brandy or beer, but that they are very temperate. The real state of affairs can be learned only by cross-questioning. Only thus the patient is induced to reveal what quantities of liquor he daily consumes. The abuse of tobacco the patient readily acknowledges.

In my sphere of activity, I had frequent opportunity to observe the genuine atrophy of the optic nerve. In relation to the whole number of my patients, the percentage is very high. Of all employments, I found those of locksmiths, blacksmiths, firemen, and weavers to be most prolific in this affection. It is difficult to decide in what degree, in the three former classes, the trade itself, *i. e.*, the prolonged exposure to fire, is to be regarded as the principal cause of the affection, as the abuse of alcoholic liquors and of tobacco is very prevalent among the classes mentioned. But of weavers we are justified to say that their trade, involving excessive exertion of sight from their earliest age, is the main cause of the affection of the optic nerve. The first symptoms of the affection, which usually begin between the ages of 30 and 41 years, manifest themselves in asthenopic troubles. Glasses bought from the optician or the dealer in spectacles afford a slight and transient relief. But soon the glasses do not suit any longer, and the patients are obliged to take at short intervals higher number of glasses, without much avail. In this state, the patient consults the oculist. The complaints of these pale, ill-fed people are so nearly alike in all cases that, with some experience, a sure diagnosis can be made already after the first preliminary questions. The form of atrophy in these cases is not a malignant one. Often we do not only succeed in arresting the morbid process, but in restoring normal vision, with permanent success.

Of the women there were :

2 seamtresses, aged, respectively, 55 and 59 years.
1 school-teacher's wife, 43 years old.
1 weaver's wife, 61 years old.

The school-teacher's wife was blind of the right eye only. The left eye, suffering, too, from atrophy of the optic nerve, had still vision of $\frac{15}{50}$. There were no special causes of the affection.

The seamstresses and the weaver's wife were blind of both eyes. Excessive exertion of vision from earlier age was ascertained as the main cause of blindness in those three cases.

b. Secondary affections of the optic nerve, in consequence of lesions of the cerebro-spinal nervous system.

18 cases of blindness: 14 in men, 2 in women, and 2 in children.

Of the men there were:

Saloon-keepers,	2	Surveyor,	1
Factory manager,	1	Merchants,	2
Silk-weaver,	1	Locksmith,	1
Grocer,	1	Farmer,	1
Tailor,	1	Tiler,	1
Harnessmaker,	1	Man-of-letters,	1

The morbid process, which always affected both eyes, led in 8 cases to blindness of both eyes, and in 6 cases to monocular blindness.

Of the four patients blind of the right eye, the left eye had vision, respectively, of $\frac{15}{200}$, $\frac{3}{100}$, $\frac{5}{1000}$, and $\frac{2}{1000}$.

Of the two patients blind of the left eye, the right eye had vision, respectively, of $\frac{15}{70}$ and $\frac{15}{200}$.

The ages of these six patients varied between 20 and 53 years.

In these cases the cause of blindness was:

1. *Concussion of the brain*, caused by falling from a height of 45 feet (case of a tiler 20 years old).

2. *Concussion of the brain* and *encephalitis*, caused by falling from a steeple (case of a locksmith 25 years old).

3, 4, 5. *Tabes dorsualis* (cases of the two merchants, aged respectively 33 and 45 years; and of the surveyor, 50 years old).

The ages of the patients blind of both eyes were from 42 to 63 years.

In these the cause of blindness was:

1. *Tabes dorsualis* (case of the factory manager, 42 years old).
2. *Tumor cerebri* (case of a saloon-keeper, 46 years old).
3. *Tabes dorsualis* (case of a saloon-keeper, 49 years old).
4. *Tabes dorsualis* (case of the silk-weaver, 50 years old).

5. *Softening of the brain* (case of the man-of-letters, 50 years old)
6. *Genuine encephalitis* (case of the tailor, 53 years old).
7. *Tabes dorsualis* (case of the grocer, 54 years old).
8. *Progressive paralysis* (case of the harness-maker, 63 years old).

The morbid process of the eyes was :

Atrophy of the optic nerve, in 11 cases.	Neuro-retinitis descendens, in 3 cases.

Of the women there were :

1. Merchant's widow, 48 years old, blind of the left eye. The morbid process was atrophy of the optic nerve of both eyes, with V. = $\frac{15}{70}$ of the right eye.
2. Officer's wife, 43 years old, blind of both eyes, in consequence of meningitis basilaris. The morbid process of both eyes was neuro-retinitis descendens.

The two children : shoemaker's child, 3 years old, and workman's child, 4 years old, were blind of both eyes in consequence of tumor of the brain. The morbid process of the eyes was in each case neuro-retinitis.

G.—*Glaucoma.*

This affection caused 41 cases of blindness : 28 in men and 13 in women.

Of the men there were :

Pauper in almshouse,	1	Baker,	1
Joiner,	1	Weavers,	4
Mason,	1	School-teacher,	1
Blacksmiths,	2	Farmer,	1
Merchants,	4	Tailors,	2
Workmen,	4	Organ-grinders,	2
Servants,	2	Mechanical engineer,	1
Designer,	1		

There were blind : of both eyes, 13 ; of the right eye, 7 ; of the left, 8.

Their ages were :

From 30 to 45 years,	2	From 61 to 70 years,	9
" 46 to 60 years,	14	" 71 to 80 years,	3

Of the patients blind of both eyes, iridectomy was performed only in 9 cases, viz., seven times on both eyes, twice on one eye

only. In three cases, there was a double transverse iridectomy of one eye.

Of the patients blind of one eye, iridectomy was performed in 9 cases, a double transverse iridectomy in 1 case. In 6 cases iridectomy was either refused or neglected.

As to the other eye of the cases of monocular blindness, the statements were as follows:

In 6 cases, where the other eye was suffering from glaucoma, the morbid process was stopped by a timely iridectomy. The vision of these eyes was: $\frac{15}{100}$ in 1 case, $\frac{15}{70}$ in 2 cases, $\frac{15}{40}$ in 1 case, $\frac{15}{20}$ in 2 cases, with more or less limitation of the field of vision.

In 7 cases, the other eye was perfectly normal, with vision of:

$\frac{15}{12}$ in 1 case.	$\frac{15}{20}$ in 2 cases (with Hm. $\frac{1}{14}$ and $\frac{1}{18}$).
$\frac{15}{15}$ in 2 cases.	$\frac{15}{30}$ in 2 cases (with Hm. $\frac{1}{12}$ and $\frac{1}{8}$).

In 2 cases with vision of $\frac{15}{15}$ and $\frac{15}{20}$ (in the latter case with Hm. $\frac{1}{16}$), there was suspicion of glaucoma.

The blind eyes on which iridectomy had been performed yielded the following facts:

In 6 cases the operation was very defective. The section was in the cornea, the coloboma very small, and the edges of the iris were grown together with the cornea.

In 2 cases the papillary part of the iris had not been excised.

In 4 cases the capsule of the lens had been wounded in the operation, thus giving rise to traumatic cataract.

Six cases showed cystoid cicatrization.

Of the women there were:

Seamstress,	1	Merchants' wives,	2
Shoemaker's wife,	1	Weaver's wife,	1
Laborers' wives,	4	Clerk's wife,	1
Laborers' widows,	3		

There were blind: of both eyes, 3; of the right and of the left eye, each 5.

Their ages were:

From 45 to 60 years,	3	From 71 to 80 years,	2
" 61 to 70 years,	8		

Only in one of the cases of blindness of both eyes, iridectomy had been made on one eye.

In the cases of monocular blindness, iridectomy had been performed only six times. In the other four cases iridectomy had been either refused or neglected.

In three of the cases of monocular blindness, the other eye had likewise been suffering from glaucoma.

Here the morbid process had been checked by iridectomy. In those eyes vision was:

$\frac{15}{30}$ in one case, without limitation of field of vision.
$\frac{15}{20}$ in two cases, with limitation of field of vision upwards-inwards; and with Hm. $\frac{1}{24}$ in one case, and M. $\frac{1}{6}$ in the other.

In the other patients, the second eye was normal. Five patients had vision = $\frac{15}{15}$, with Hm. $\frac{1}{18}, \frac{1}{10}, \frac{1}{8}$ in three cases, and with emmetropia in two cases. Two patients had vision = $\frac{15}{20}$ with M. $\frac{1}{24}$ in one case, and emmetropia in the other.

In three of the cases of blindness, iridectomy had been performed in a very defective manner; in two, the capsule of the lens had been injured, giving rise to consecutive cataract.

Final Result.

Glaucoma apoplecticum, in 3 cases.
Glaucoma absolutum, with circular posterior synechiæ, in 3 cases.
Glaucoma absolutum, in 24 cases.
Glaucoma absolutum, consecutive cataract, in 2 cases.
Glaucoma absolutum, consecutive cataract, anterior staphyloma of the sclera, in 3 cases.
Glaucoma absolutum, with consecutive cataract, in consequence of lesion of the capsule of the lens during iridectomy, in 6 cases.

H.—*Unsuccessful Operations.*

The operations led to blindness in 32 cases: 18 men, 11 in women, and 3 in children.

Of the men there were:

Workmen,	4
Private gentleman,	1
Pauper in almshouse,	1
Printer,	1
Merchants,	2
Weavers,	3
Ragman,	1
Cabinetmaker,	1
Locksmiths,	2
Fireman,	1
Farmer,	1

Their ages were:

Between 16 to 40 years,	5	Between 61 to 70 years,	6
" 46 to 60 years,	8	83 years,	1

Iridectomy led to blindness of the right eye in one case. Operation of cataract caused blindness in 17 cases: 11 times in the right, and 7 in the left eye (both eyes in one case).

The women were:

Factory women,	4	Merchants' wives,	2
Seamstress,	1	Workman's widow,	1
Farmer's wife,	1	Cabinetmaker's wife,	1
Factory girl,	1		

Their ages were:

From 16 to 45 yeaes,	3	From 61 to 75 years,	4
" 46 to 60 years,	4		

Iridectomy led to blindnes in two cases: of one right and one left eye. Cataract operation caused blindness of 9 cases: 7 right and 4 left eyes (of both eyes in two cases).

The children were:

1. Driver's daughter, 10 years old, loss of the right eye, in consequence of discission of a congenital cataract.
2. Weaver's son, 12 years old, loss of the left eye in consequence of extraction of traumatic cataract.
3. Merchant's son, 14 years old, loss of the left eye in consequence of advancement of external rectus.

Final Result.

a. After operations of cataract.

Total leucoma of the cornea, closure of the pupil, detachment of retina, in 3 cases.
Irido-choroiditis absoluta, with closed pupil, in 5 cases.
Irido-cyclitis (of both eyes in two cases), in 11 cases.
Phthisis of the eyeball (of both eyes in one case), in 5 cases.
Stump of the eyeball, in 4 cases.

b. After iridectomy.

Irido-choroiditis absoluta, atrophy of the eyeball, in 1 case.
Panophthalmitis, in 1 case.
Irido-cyclitis, phthisis of the eyeball, in 1 case.

c. After advancement of external rectus.

Panophthalmitis, in 1 case.

I.—*Unknown Causes.*

37 cases of blindness, of 23 men and 14 women, are mentioned in my diaries, the etiology of which either could not be ascertained at the time of examination, or was not recorded.

The men were :

Weavers,	3	Painter,	1
In blind asylum,	1	Butcher,	1
Clerks,	2	Cabinetmaker,	1
Gardener,	1	Postmaster,	1
Factory men,	7	Baker,	1
Dyer,	1	Organ-grinder,	1
Locksmiths,	2		

There were blind : of both eyes, 2 ; of the right eye, 12 ; of the left, 9.

Their ages were :

From 16 to 30 years,	9	From 46 to 60 years,	3
" 31 to 45 years,	10	63 years,	1

Of the women there were :

Store-girl,	1	Workwomen,	4
Weaver's wife,	1	Servant-girl,	1
Merchant's daughter,	1	Nurse,	1
Plumber's wife,	1	Cutter's daughter,	1
Shoemaker's wife,	1	Workmen's widows,	2

There were blind : of the right eye, 9 ; of the left, 5.

Their ages were :

From 20 to 30 years,	8	From 46 to 60 years,	3
" 31 to 45 years,	2	65 years old,	1

Final Result.

Phthisis of the eyeball, in 4 cases.

Stump of the eyeball (of both eyes in two cases ; the blindness of one case was attributed to some nervous disease), in 6 cases.

Anophthalmus in consequence of enucleation, in 18 cases.

Atrophy of the eyeball, in 6 cases.

Irido-cyclitis, in 2 cases.

Partly absorbed cataract, with secondary membranous cataract and detachment of retina (perhaps congenital), in 1 case.

K.—*Tumors of the Eye.*

1. *Intraocular tumors* caused 12 cases of blindness, viz.:

a. Sarcoma of the choroid caused 7 cases of blindness: 4 in men, and 3 in women.

The men were:

1. Cooper, 60 years old. Sarcoma of the right eye. L. E., Em., V. $= \frac{15}{15}$.
2. Workman, 25 years old. Sarcoma of the right eye. L. E., M. $\frac{1}{36}$, V. $= \frac{15}{20}$.
3. Baker, 46 years old. Sarcoma of the left eye. R. E., Hm. $\frac{1}{20}$, V. $= \frac{15}{40}$.
4. Merchant, 80 years old. Sarcoma of the left eye. R. E., Em., V. $= \frac{15}{40}$.

In one case (baker), the other eye was affected by sympathetic ophthalmia. The blind eye presented all the symptoms of an inflammatory glaucoma. Iridectomy produced no improvement. Enucleation of the eyeball corroborated the diagnosis and removed the ophthalmia of the other eye.

All patients were perfectly healthy and had no hereditary disposition.

Of the women there were:

1. Waiter's wife, 54 years old. Sarcoma of the right eye. L. E., Em., V. $= \frac{15}{15}$.
2. Turner's daughter, 18 years old. Sarcoma of the left eye. R. E., Em., V. $= \frac{15}{15}$.
3. Weaver's daughter, 26 years old. Sarcoma of the right eye. L. E., Hm. $\frac{1}{6}$, V. $= \frac{15}{20}$.

The waiter's wife, perfectly healthy, was the mother of four healthy children. No hereditary disposition.

Both girls were very scrofulous and very poorly developed. The weaver's daughter, 16 years old, had not yet had her menses. Her grandmother on the mother's side, 65 years old, was operated by me for carcinoma of the inferior lid of the left eye.

b. Glioma of the retina caused five cases of blindness, *i. e.*, in five children, viz.:

1. Merchant's child, 2½ years old. Glioma of the left eye.
2. Plumber's child, 3 years old. Glioma of the left eye.
3. Cabinet-maker's child, 3 years old. Glioma of the right eye.
4. Workman's child, 5 years old. Glioma of the left eye.
5. Locksmith's child, 6 years old. Glioma of the right eye.

The merchant's child, 2½ years old, was the first-born. The first symptoms of the affection (a peculiar white reflex from the left eye) was observed by the mother at the end of its first year. The right eye was normal, with blue iris. No similar cases of affection had been observed in the families of either parent. A second child had normal eyes.

The plumber's child, 3 years old, last-born, had still four living sisters and brothers with normal eyes. One brother, who died, 3 years old, of inflammation of the brain, was said to have suffered from the same affection. The duration of the affection could not be ascertained. The right eye was normal, with gray iris.

The cabinet-maker's child, 3 years old, last-born, had a brother 10 years old, with normal eyes. No similar cases of affection had been observed in the families of either parent. The first symptoms of the affection were observed by the mother half a year previously. The left eye was normal, with blue iris.

The workman's child, 5 years old, had still three living brothers and sisters. It was the youngest of seven brothers and sisters of the same mother. The latter was operated, some years before, for carcinoma of the breast, and died one year later from relapse. The first symptoms of the eye-disease had been observed by the father at the fourth year of the age of the child. The right eye was normal, with dark-brown iris.

The locksmith's child, 6 years old, was the only issue after a long period of sterility. The parents were heathy. The first symptoms of the affection had been noticed by the mother one year previously. The left eye was normal, with greenish iris.

There was consanguinity of the parents only in one case (plumber).

Only in two cases I had an opportunity to follow up the subsequent history of the children.

1. One year after the enucleation of the eye of the workman's child, multiple glandular tumors developed on the neck and in the inguinal region, in consequence of which the child died.

2. On the merchant's child there appeared, six months after the enucleation of the left eye, a small detachment of retina of the right eye, which developed but very little during the three months it was under my observation. At the end of the year the child died from hydrocephalus.

2. *Extraocular* (*resp. orbital*) *tumors* caused six cases of blindness, viz.:

a. Sarcoma of the orbit caused five cases of blindness, 3 in men and 2 in women.

Of the men there were:

1. Workman, 20 years old. Sarcoma of the left eye. R. E., Em., V. = $\frac{15}{15}$.

2. Baker, 41 years old. Sarcoma of the right eye. L. E., Em., V. = $\frac{15}{15}$.

3. Brewer, 47 years old. Sarcoma of the right eye. L. E., M. $\frac{1}{8}$, V. = $\frac{15}{20}$.

In two cases there was exophthalmus with atrophy of the optic nerve; in one case, exophthalmus, suppuration of the cornea, and panophthalmitis.

Of the women there were:

1. Seamstress, 22 years old. Sarcoma of the left eye. R. E., Hm. $\frac{1}{24}$, V. = $\frac{15}{15}$.

2. Weaver's wife, 38 years old. Sarcoma of the left eye. R. E., Hm. $\frac{1}{36}$, V. = $\frac{15}{20}$.

In both cases there was exophthalmus and atrophy of the optic nerve.

All patients were otherwise perfectly healthy, and there was no hereditary disposition in them.

During the seven years, in the course of which I had an opportunity of observing the seamstress after removal of the tumor, I could not find any trace of a relapse.

b. Echinococci in the right orbit caused blindness of the right eye of a child four years old, the son of a dyer. There was exophthalmus and atrophy of the optic nerve.

L.—*Congenital Blindness*

was observed in 8 cases, which I state here only briefly, reserving further particulars for another place.

The different forms of the morbid process causing blindness were as follows:

1. *Keratitis intra-uterina.* Complete opacity of both corneæ with central band-shaped leucoma and posterior synechiæ. Observed on both eyes of a seven-weeks-old child.

2, 3. *Choroideo-retinitis intra-uterina absoluta.* Observed on both eyes, both in a baker's child, six months old, and in a blacksmith's child, six weeks old.

4–7. *Congenital Anophthalmus** observed in:

1. Workman's child, three months old, on the right side.
2. Plumber's child, four weeks old, on both sides.
3. Weaver's child, two weeks old, on the left side.
4. Weaver, 25 years old (father of the former child), on the right side.

8. *Congenital buphthalmus* of the right eye, observed in a shoemaker's child, three weeks old.

M.—*Consecutive blindness, viz., such as was caused either by constitutional diseases or by affection of other organs of the body.*

Of this class we have 35 cases of blindness, the remote causes of which are:

a. Small-pox.†

It caused 14 cases of blindness, viz., in consequence of:

1. *Blennorrhoic Conjunctivitis,*

one case of a shoemaker, 35 years old, whose left eye was lost by suppuration of the cornea. The patient had been vaccinated.

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* For further particulars on those four cases of anophthalmus congenitus see: Klinische Monatsblätter für Augenheilkunde. April, 1877.

† For further particulars see: Beiträge zur variolösen Ophthalmie by the author. Elberfeld Martini or Gruettefien, 1874.

2. *Affections of the Cornea,*

13 cases, 4 in men, 6 in women, and 3 in children.

Of the men there were:

1 Peddler, 46 years old.
1 Clerk, 25 years old.
2 Weavers, resp. 48 and 50 years old.

Of these only one had been vaccinated.

There were blind: of both eyes, 1; of the right eye, 2; of the left eye, 1.

Of the women there were:

1 Servant girl, 28 years old.
1 Baker's wife, 34 years old.
1 Weaver's wife, 50 years old.
1 Factory girl, 26 years old.
1 Merchant's daughter, 24 years old.
1 Locksmith's wife, 48 years old.

Of these only one had been vaccinated.

There were blind: of both eyes, 1; of the right eye, 3; of the left eye, 2.

Of the children, all three weavers' children, between the ages of 4 and 10 years, *none* had been vaccinated. There were blind: of the right eye, two; of the left eye, two.

Final Result.

Phthisis of the eyeball, in 3 cases.
Atrophy of the eyeball (of both eyes in one case), in 4 cases.
Stump of the eyeball, in 2 cases.
Total leucoma of the cornea, staphyloma of the iris, in 1 case.
Total leucoma of the cornea, consecutive glaucoma, in 1 case.
Opaque staphyloma of the cornea (of both eyes in one case), in 2 cases

*b. Severe Hemorrhages**

caused four cases of blindness, viz.:

1. Trader, 63 years old. Loss of vision of both eyes immediately after blood-vomiting.
2. Seamstress, 36 years old. Loss of vision of the right eye two weeks after profuse metrorrhagia had been stopped.
3. Merchant's daughter, 24 years old. Gradual loss of vision of the left eye in consequence of profuse epistaxis.

* For further particulars on the first three cases, see: Klinische Monatsblätter für Augenheilkunde. March, 1877.

4. Baker's wife, 47 years old. Loss of vision of the right eye in consequence of profuse metrorrhagia, caused, according to the diagnosis of a gynæcologist, by a fibroid of the uterus. The blindness of the right eye developed through progressive atrophy of the optic nerve. The morbid process occupied the space of one year. Every attack of metrorrhagia was followed by an impairment of vision, while, during the free intervals, the sight of the eye remained stationary, slight fluctuations excepted. The left eye remained normal.

c. Puerperal Affections

led to blindness, through irido-choroiditis metastica, in three cases, viz.:

Of a driver's wife, 44 years old. Loss of both eyes.
Of a saloon-keeper's wife, 30 years old. Loss of both eyes.
Of a cutler's wife, 25 years old. Loss of the right eye.

d. Cerebro-spinal Meningitis

led to blindness of three children, viz.:

Of a weaver's son, 20 weeks old. Loss of the right eye.
Of a merchant's son, one year old. Loss of the right eye.
Of a baker's son, three years old. Loss of both eyes.

Final Result.

Amauratic "cat's-eye," in 1 case.
Phthisis of the eyeball, amaurotic "cat's-eye," in 1 case.
Atrophy of the optic nerve, slight phthisis of both eyes, in 1 case.

e. Typhoid Fever

caused blindness in two cases, viz.:

1. P. G., farmer, 40 years old. In the fifth week of the disease, F. made the following notes respecting the right eye: Protrusion of the eyeball, with complete immobility. Chemosis of the conjunctiva of the globe, which surrounds the cornea like a wall. Cornea clear. Tissue of the iris greenish, with serous infiltration. Exudations on the lens. Intraocular pressure increased. Orbit free. Slight pain. Amaurosis. Affection since about 8 days.

2. B. D., workman's wife, 40 years old, recovering from typhoid fever. In the sixth week of the disease, vision of the right eye had become impaired, while otorrhœa of the right ear set in. When four weeks afterwards the patient came to me, I made the following notes respecting the right eye:

The exterior of the right eye is normal. Its refracting media are

clear. Pupil normal, when both eyes are open; of medium dilatation, when the left eye is closed. It reacts well by reflex; but does not react consensually even upon concentrated light. Intraocular pressure normal. Amaurosis.—The ophthalmoscope showed *neuritis optica* and *slight infiltration of the retina.*

The right side of the head is very sensitive to palpation. Much headache.

The left eye was normal.

Therapeutic measures were fruitless.

f. Measles

were said to have caused blindness of a girl six years old; grocer's daughter. The parents stated that their child lost both eyes a year before, while suffering from the measles.

The examination of the eyes gave the following result:

The exterior of the eyes is normal; pupils moderately dilated, immovable; refracting media clear; atrophy of the optic nerve.

g. Heart Diseases

caused blindness of four cases, viz.:

1. Harness-maker, 67 years old. Blind of the right eye.
2. Merchant, 65 years old. Blind of the right eye.
3. Merchant, 47 years old. Blind of the right eye.
4. Agent, 45 years old. Blind of both eyes.

In the cases of monocular blindness there was *insufficiency of the semilunar valves and stenosis at the aortic orifice* in two cases, complicated with atheromatous degeneration of the arteries.

In the case of blindness of both eyes there was *endocarditis* consequent to acute rheumatism of joints.

In all four cases the background of the eye showed *embolism of the central artery of the retina.*

h. Gonorrhœa

led to blindness in four cases, the gonorrhœal matter being transferred into the conjunctiva, viz.:

1. Shoemaker, 23 years old. Blind of both eyes. There was *gonorrhœal conjunctivitis and suppuration of both corneæ.* Patient was suffering from gonorrhœa for three weeks. The first symptoms of inflammation of the eyes appeared on the sixth day of the gonorrhœal affection.

2. Grocer's apprentice, 19 years old. Blind of the left eye. There was *gonorrhœal conjunctivitis and total maceration of the cornea* of the left eye. Patient was suffering from gonorrhœa for six weeks and from gonorrhœal conjunctivitis for two weeks.

3. Joiner, 26 years old. Blind of the left eye. Suffering for three weeks from gonorrhœa, and for 8 days from gonorrhœal conjunctivitis of both eyes. The left cornea was totally destroyed. Of the right cornea there were some peripheric infiltrations.

4. Merchant, 35 years old. Blind of the right eye in consequence of gonorrhœal conjunctivitis, caused by self-infection. The eye showed *total leucoma of the cornea and slight atrophy of the eyeball.*

i. Syphilis

caused blindness in two cases, viz.:

1. G. P., factory man, 49 years old. *R. E.* periosteal growth of the orbit. Highly developed exophthalmus. Choked disc. *Final result: Suppuration of the cornea and phthisis of the eyeball.*

The patient states to have been infected three years previously for the first time, and has *defects in the soft palate and periosteal swellings of the tibiæ.*

2. A. P., workman, 37 years old. Atrophy of both discs. Amaurosis of the right eye. Vision of the left eye $= \frac{15}{70}$. In addition, hemiplegia, multiple exostoses of the cranium. Affection six years previous. Very high degree of mercurial cachexia.

N.—*Traumatic Lesions of the Eye*

caused 118 cases of blindness: 71 in men, 19 in women, and 28 in children.

Of the men there were:

Locksmiths,	8	Railroad officer,	1
Book-binder,	1	Engraver,	1
Masons,	4	Stone-cutters,	5
Merchants,	3	Soldiers,	2
Clerks,	3	Copyists,	2
Blacksmiths,	12	Weavers,	2
Factory-men,	20	Carrier-boy,	1
Dyers,	2	Butcher,	1
Grocer,	1	Turner,	1
Joiner,	1		

There were blind: of both eyes, 3; of the right eye, 32; of the left, 36.

The ages were:

From 16 to 30 years,	40	From 46 to 60 years,	7
" 31 to 45 "	21	" 61 to 75 "	3

Nature of the Lesions.

1. Superficial lesions of the cornea, in 4 cases.
2. Perforating wounds of the cornea, in 34 cases.
3. Perforating wounds of the cornea and sclera, in 15 cases.
4. Perforating wounds of the sclera, in 11 cases.
5. Interior lesions of the eye, in 7 cases.

Causes of the Lesions.

A. *In the pursuit of professional duties.*

1. Perforating wounds of the eyeball, caused by sharp instruments, in 5 cases.
2. Foreign bodies penetrating the eyeball, in 21 cases.

B. *By assault and battery.*

1. Throwing of stones, in 3 cases.
2. Blows, in 5 cases.
3. Whip-lashes, in 3 cases.
4. Stabbing with knife, in 10 cases.
5. Stabbing with dung fork, in 2 cases.

C. *By accident.*

1. Kick of a horse, in 2 cases.
2. Injury with penknife (caused by children while playing), in 3 cases.
3. Injury with fork (caused by children while playing), in 1 case.
4. Falling down-stairs, in 4 cases.
5. Injury through champagne-cork, in 1 case.
6. Injury through pieces of broken glass (falling against a window pane), in 2 cases.

D. *By scalding.*

1. Scalding, in 1 case.

E. *In the war.*

1. Grape-shot, in 1 case.
2. Bayonet-stab, in 1 case.

F. Through explosion.

1. Percussion cap, in 4 cases.
2. Gunpowder, in 2 cases.

In one case, in which irido-cyclitis caused the loss of one eye, in consequence of penetrating foreign body, the other one became blind three years afterwards, from sympathetic ophthalmia.

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In one case, in which blindness of one eye was caused by a penetrating wound of the cornea and sclera, in consequence of falling down-stairs, the other eye became blind in the same year through irido-cyclitis sympathica.

In one of the cases of lesion through explosion of gun-powder, caused while mining, both eyes were lost through panophthalmitis.

Final Result.

Leucoma corneæ centr. adhærens, membrane in pupil, detachment of retina, in 5 cases.
Leucoma corn. adhær., irido-cyclitis sympathica, in 4 cases.
Leucoma corn. adhær., phthisis of the eyeball, in 3 cases.
Irido-chor. abs., staphyloma of the corn. and sclera, in 2 cases.
Irido-chor. abs., closed pupil, detachment of retina, in 6 cases.
Irido-cyclitis sympathica (in three cases complicated with staphyloma of the cornea and sclera), in 15 cases.
Phthisis of the eyeball, in 3 cases.
Defect of the eyeball in consequence of enucleation, in 3 cases.
Panophthalmitis, in 3 cases.
Rupture of the choroidea with atrophy of the optic nerve, in 3 cases.
Phthisis of the eyeball, in 8 cases.
Atrophy of the eyeball, in 5 cases.
Stump of the eyeball, in 4 cases.
Atrophy of the optic nerve, in 2 cases.
Detachment of retina and hemorrhages in vitreous, in 2 cases.
Irido - chor. absoluta, secondary glaucoma, in 3 cases.

Of the women there were:

Inn-keeper's daughter,	1	Factory women,	4
Nurse,	1	Seamstress,	1
House-keeper,	1	Baker's wife,	1
Merchant's wife,	1	Servant-girls,	2
Workmen's wives,	7		

There were blind: of both eyes, 1; of the right eye, 10; of the left, 8.

The ages were:

From 20 to 30 years,	11	From 46 to 65 years	4
" 31 to 45 "	4		

Nature of the Lesions.

1. Superficial lesion of the cornea, in 1 case.
2. Perforating wounds of the cornea, in 10 cases.
3. Perforating wounds of the cornea and sclera, in 4 cases.
4. Perforating wounds of the sclera, in 4 cases.

Causes of the Lesions.

A. *By accident.*

1. Foreign bodies penetrating into the interior of the eyeball, in 4 cases.
2. Stabbing with penknife (caused by children while playing), in 2 cases.
3. Stabbing with a pair of scissors, in 2 cases.
4. Falling against a pointed object, in 1 case.
5. Injury through pieces of broken glass, in 1 case.

B. *By assault and battery.*

1. Blows, in 3 cases.
2. Stabbing with forks, in 2 cases.
3. Stabbing with knife, in 2 cases.
4. Blow with a beer-glass, in 1 case.

C. *By burning.*

With lime, in 1 case.

The blindness of both eyes was observed in the case of a girl who, four years old, lost her left eye, struck by a piece of broken glass. Ten years afterwards, sympathetic ophthalmia set in in the right eye, causing blindness, notwithstanding the enucleation of the left eye and all subsequent treatment.

Final Result.

Irido-cyclitis sympathica, in two cases, complicated with staphyloma of the cornea and sclera, in 9 cases.
Irido-chor. absoluta with consecutive glaucoma, in 2 cases.
Atrophy of the eyeball, in 2 cases.
Phthisis of the eyeball, leucoma corn. adhærens, in 3 cases.
Leucoma corn. adhærens, consecutive glaucoma, in 2 cases.
Defect of the eyeball in consequence of enucleation, in 1 case.

Of the children there were:

Waiter-boy,	1	Merchants' children,	3
Joiners' children,	4	Drivers' children,	2
Tailor's child,	1	Weavers' children,	3
Grave-digger's child,	1	Shoemaker's child,	1
Mason's child,	1	Workmen's children,	9
Blacksmiths' children,	2		

There were blind: of the right eye, 13; of the left, 15.

Their ages were:

From 1 to 5 years,	10	From 11 to 15 years,	5
" 6 to 10 "	13		

Nature of the Lesions.

1. Superficial lesion of the cornea, in 1 case.
2. Perforating wounds of the cornea, in 15 cases.
3. Perforating wounds of the cornea and sclera, in 8 cases.
4. Perforating wounds of the sclera, in 4 cases.

Causes of the Lesions.

A. *Through carelessness.*

1. Exploded percussion-caps penetrating the eye, in 6 cases.
2. Explosion of gun-powder, in 3 cases,
3. Injury with penknife, in 3 cases.
4. Injury with fork, in 2 cases.
5. Stabbing with a pair of scissors, in 1 case.

B. *By assault and battery.*

1. Throwing with stones, in 3 cases.
2. Stabbing with knife, in 4 cases.
3. Blow with a hammer, in 1 case.

C. *By accident.*

1. Falling against a pointed object, in 3 cases.
2. Injury by a spinning top, in 1 case.
3. Blow with brushwood, in 1 case.

Final Result.

Irido-cyclitis sympathica, phthisis of the eyeball (in one case complicated with staphyloma of the cornea and sclera), in 11 cases.

Panophthalmitis, in 3 cases.

Irido-chor. absoluta, phthisis of the eyeball (in two cases complicated with staphyloma of the cornea and sclera), in 5 cases.

Atrophy of the eyeball, traumatic cataract, in 2 cases.

Traumatic cataract, detachment of retina, in 2 cases.

Leucoma corn. adhær., irido-chor. absoluta, in 3 cases.

Absence of the eyeball in consequence of enucleation, in 2 cases.

A glance into the causes of blindness consequent to the lesions of the eye gives us sufficient reason to establish the fact that, with proper caution, in these cases also the greater part might have been avoided. But we not only meet with carelessness and thoughtlessness of the parents, who give their children cutting or sharp playthings in order to pacify them; not only do we meet with the same recklessness prevailing among the boys, in the manner in which they manage explosive materials, preferring them especially as pastime; but we see the same faults committed, to the same extent, especially

among those classes which, in consequence of their trade, are daily exposed to the dangers of lesion of the eye, and which have daily opportunity to learn from personal experience the serious consequences of such an injury. But, as on one hand persons become familiar with the dangers by which they are surrounded, and consequently underrate them; on the other hand, it is very difficult for them to free themselves from the fetters of routine and old habits. In the first years of my practice at Elberfeld, I endeavored to bring into use the protective mica spectacles, recommended by Cohn of Breslau, among those workmen who are especially exposed to injuries of the eye. My intention was met with unanimous opposition. Even such workmen as had already lost one eye in their occupation could not be induced to wear protective spectacles while working. The one alleged that spectacles were disagreeable to him while at work; the other stated that the use of spectacles drew too much the attention of other workmen upon him. Besides, there existed among all a great portion of fatalism, and they preferred to subject themselves to a risk rather than to overcome a transient discomfort.

Experience is indeed the great teacher of men, but the advance of the knowledge derived from it is very slow against the indolence of the multitude. To point out existing evils and to pave the way for a better future is the pre-eminent duty of the physician. We hope that the labor and pains of experience and science will not prove fruitless, and that in the long centuries before us there will be a time when the principles of a rational hygiene will result in permanent benefits to all classes of society.

OPHTHALMOLOGICAL COMMUNICATIONS.

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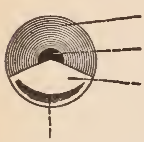
1. *Congenital ulcerated Leucoma of the Cornea.*

On Dec. 31st, 1875, I was called by the attending physician to see a girl seven days old. Her birth had been normal, easy, and took but an hour without necessitating medical aid. The child was born at full term; she was strong and healthy. Nothing abnormal was observed regarding her eyes. Although she opened them but seldom, still nothing wrong had been observed in them until the sixth day, when, without any especial reason, the attending physician opened them, and then called me in consultation for the next day, on account of what he found. I diagnosed on the right eye a *dense leucoma*, as represented in the figure.



The upper border covered the lower part of the pupil completely, so that nothing could be seen, either of it or of the iris; it was entirely opaque, and as white as a gerontoxon. The remaining part of the cornea and also the left eye were perfectly normal.

Of the white spot itself, the greater portion, corresponding to the region of a lower arcus senilis, and also about one-half a millimetre distant from the visible lower corneal margin was necrotic; see the figure.

This portion of the cornea was, so to speak, filled up with necrotic tissue. The crescent-shaped ulceration was very deep, tolerably well defined, and there seemed to be only a very thin layer of corneal tissue that separated it from the anterior chamber. That portion of the leucoma located above the deep crescent-shaped ulceration was entirely smooth and shining, but appeared somewhat vesicular in its uppermost layers.

The anterior chamber was present, the lens was clear, the conjunctiva bulbi but little reddened.

From this day on, one drop of atropia was applied to the eye. I directly pencilled at the same time the ulcerated portion of the cornea with

a watery solution of salicylic acid (0.03 : 15.0) once daily, in accordance with Dr. Horner's method—a treatment (including aq. chlori) that furnishes remarkably favorable results in cases of ulcerous keratitis and hypopyon keratitis.

Already on the second day the ulcer looked cleaner, and the vesicular elevation of the cornea became smoother. On the fifth day, a spasmodic entropion of the lower eyelid manifested itself, that delayed the cure somewhat. Henceforth we brushed with pure aq. chlori every other day.

On the 10th day there being some mucous secretion from the conjunctiva, a weak solution of zinc was instilled. In spite of the repeated recurrence of the spasmodic entropion, the ulcer flattened more and more, and healed entirely from the points of the crescent in twenty days. In the mean time, the upper margin of the leucoma retreated somewhat, so that a greater part of the pupil became visible.

After four weeks, the patient was discharged with a leucoma of the lower half of the cornea, reduced to one-half of its original circumference, and had become more transparent. The most opaque portion was now the centre of the mostly ulcerated crescent.

When I again saw the little patient, after two months, the leucoma had retracted still more from the centre of the cornea, so that now the whole pupil was clearly visible. The greatest opacity still corresponded to the most central and deepest portion of the former ulcer.

In this case it must be assumed that the leucoma was congenital—it could have been nothing else—and that the process of ulceration commenced, at the furthest, immediately after birth, on account of its considerable extent regarding its depth and surface. Nay, it seems even probable that it commenced in utero. No similar changes had been observed on the eyes of either parents or grandparents.

2. *Congenital Absence of the four Puncta Lachrymalia and Canaliculi.*

G. Z.; 18 years of age, had been treated by me for stenosis of the lachrymal duct for one year, he having suffered from the overflow of tears as long as he could remember, when his brother E., aged 6, was brought to me for the same trouble. The boy's eyes were continually moist, and the edges of the lids in consequence slightly ulcerated—a condition which, his mother assured me, had existed ever since birth.

A superficial examination showed all four puncta to be entirely wanting.

Numerous attempts to enter one of the canaliculi having proved ineffectual, I concluded that they also were wanting. With a strong, sharp silver probe I made an artificial opening at the point of entrance of the inferior canaliculus into the sack, below the anterior portion of the caruncle, which indeed led into the sac on both sides. The sac and the nasal duct were quite normal, B. 6, and even Weber's probe entering the lower part of the canal readily. It was difficult, however, to keep the artificial opening patulous, as despite the retention in it of a Weber's probe for a number of hours, it would contract noticeably during a single day. Attempts to enter a canaliculus from the sac were made repeatedly, but were futile.

For three weeks the probes were used in the above manner once a day ; after that, once a week, and still later, once every two weeks. Whenever this was done at longer intervals, it became exceedingly difficult to find the artificial openings. This mode of treatment has now been pursued during four months ; lachrymation has sensibly diminished, while the lids are again sound.

While treating the boy, I was told by his mother that her youngest child, a boy one year of age, had "running eyes," and a certain other peculiarity.

3. *Bilateral Congenital Lachrymal Fistulæ.*

At the site of the ordinary acquired lachrymal fistulæ, but slightly below it, there was to be seen in this boy A., on either side, an extremely minute opening, running like a crack from above downwards, into which the cutis seemed to dip as into a funnel. Out of this aperture a thick transparent fluid would ooze when pressure was exerted on the upper portion of the sac. Both openings and the occasional oozing of this fluid had been noticed by the mother immediately after and since the birth of the boy. The canaliculi having been incised on both sides, sounds were introduced once a day for the first two weeks, and at intervals of from two to four weeks further on. Both nasal ducts were constricted, especially so at a point just below the fistula of the sac. Repeated and energetic applications of lunar caustic to the fistulæ caused the one on the right side to disappear, but the one on the left side has resisted all treatment to this day.

These rare anomalies of the tear passages (Cases 2 and 3) are of

peculiar interest as occurring in members of a single family, a third child of which has also suffered from epiphora. The rest of the children, five in number, have normal eyes, while the ones affected are respectively the third, the seventh, and the eighth. There is no history of lachrymation in any other member of the family, except the grandfather on the father's side; but all the children are scrofulous, and the oldest of these, under my treatment, is afflicted with ozæna.

4. *Pressure on the Eye producing a Change in the Acuity of Vision.*

R. L., of Berne, has been consulting me for the last three years. He does not remember to have ever seen clearly and distinctly. Ophthalmoscopic and focal examinations reveal the existence of an almost imperceptible equally diffuse opacity of the entire lens in both eyes. This is the only change, either congenital or acquired, visible in any part of the eye or its appendages, the fundus being quite distinct. On examining the acuity of vision, I found right eye $\frac{20}{200}$, left eye $\frac{20}{40}$, when the patient declared that he would improve his own sight, and immediately, by pressing on the outer and upper part of the eye, in the region of the ciliary body, with his index-finger, he attained S. $\frac{20}{40}$ on the right eye, and S. $\frac{20}{20}$ on the left side. After separating the eyelids with my fingers, I easily induced him to exert immediate pressure on the eye, with exactly the same result as regards acuity of vision as with pressure on the eyelids.

On examining the state of refraction carefully, I found

Right eye, M. $\frac{1}{48}$, with S. $\frac{20}{40}$ after correction.
" " M. $\frac{1}{24}$, with S. $\frac{20}{40}$, after correction.

This degree of acuity was also attained by $-\frac{1}{24}$ sph., or without a correcting glass by pressure.

Left Eye, E. with $\frac{20}{20}$.
" " H. $\frac{1}{30}$, with S. $\frac{20}{20}$ after correction.

S. is the same with $+\frac{1}{36}$ sph., or on compression.

It is remarkable that, in the right eye, which is myopic, compression should produce an improvement of sight, the same as in the left eye, where there is E. and H. Astigmatism of the lens would still give a satisfactory explanation of this phenomenon, provided that the acuity of vision could be increased as much by cylindrical glasses as by pressure.

On the contrary, the astigmatism here has so little influence on the acuity of vision that spherical glasses alone, right eye $-\frac{1}{24}$, left $+\frac{1}{36}$,

produce the same amelioration of vision as cylindrical glasses or pressure.

5. *Recurrent Transitory Amaurosis.*

On March 3d, 1875, Mary G., eleven years of age, and of feeble constitution, was brought to me for the first time, as "since two days she cannot see a thing." On examination, however, I found S. $= \frac{6}{200}$ in both eyes, with correct projection, and in a second examination, the maximum acuteness of vision was determined as S. $= \frac{20}{100}$, and H. $= \frac{1}{8}$. Examination on March 3d.—Right eye: Small scar in lower segment of cornea with anterior synechia. Pupil oval. Left eye: Nubecula in the centre of cornea. Nystagmus oscillatorius oc. utr., and strabismus convergens concomitans. No perceptible ophthalmoscopic changes. Presuming that this condition might be due, in part at least, to accommodative asthenopia, I examined for hypermetropia, finding H. $\frac{1}{8}$, and S.$=\frac{20}{200}$ with $\frac{1}{8}$, which glass patient was directed to wear constantly.

On March 15th, patient, who had been doing well, states that, on awaking in the morning, she found herself totally blind. Indeed she saw nothing, and could hardly recognize the glare of a very large gas burner, while projection was normal. Ophthalmoscopically no changes were perceptible. Six drops of an aqueous solution of nitrate of strychnia were injected under the skin of the right temple on this day, and on the 16th, 17th, and 18th, but no improvement ensued. On the 19th, a weak constant current was applied to both temples during five minutes, after which patient thought she saw better or "lighter" as she expressed it; this was repeated on the 20th and 21st, without further improvement.

March 22d.—A feeble induced current was applied alternately to the right and to the left eye, the other electrode being placed on the back of the neck, and the negative and positive pole being changed from eye to neck and vice versa. This was repeated on March 23d.

March 24th.—Patient, on awaking this morning, saw enough to distinguish large objects. In the afternoon, before the use of electricity, she could not distinguish objects or fingers held in front of the eye. After the use of the induction current, she counted fingers at 6 inches.

March 25th.—Counts fingers at 6 inches *before*, and at 12 inches after electricity.

March 26th.—Patient again awoke with complete loss of sight. After electricity in the afternoon, no improvement. Hardly distinguishes light from darkness.

March 27th.—Status idem. Electricity. Calomel internally, 0.05 twice daily.

March 28th.—On awaking this morning, patient was able to make out movements of the hand. In the afternoon, after the use of the current, in the same manner as from the 22d to the 27th, she counted fingers at 6 inches.

March 29th.—Patient saw well until noon ; while at dinner, she had an attack of vertigo, followed by complete loss of sight. In the afternoon, electricity was used without effect, and again on the 30th it did not produce any change.

March 31st.—After electricity, patient counted fingers at 5 inches, on the next day after electricity at 10 inches ; on April 3d, at 20 inches. Sulphate of quinia 0.05 twice daily was now ordered. On the 5th, she counted fingers at 19 inches before, and at 22 inches after electricity ; on the 14th, having again reached S. = $\frac{20}{100}$, she was discharged for the time being.

On April 30th, at 4 P.M., patient returned. She had been attending school since her discharge on April 14th, but in the capacity of a listener only ; on this afternoon, however, she was told to do a sum, and while so doing, had experienced great fatigue, and for a short time peculiar pains in the occiput, when suddenly she became blind. She could hardly distinguish light from darkness, though the reaction of the pupil was, as it had always remained, perfect. The induced current was used during eight minutes in the manner detailed above under March 22d, and also on May 1st, but without result. On May 2d, patient awoke with sight, counting fingers at 4 inches before, at 1 foot after electricity.

By May 9th, she had again improved to S. = $\frac{10}{200}$.

May 10th.—Patient returned at 4.30 P.M., stating that she was again blind since half an hour. While playing on the piano, she had suddenly lost her sight, in this case without any of her usual premonitory head-symptoms. Again she could hardly tell what was dark and what was light, while the pupils reacted in a normal manner. The induced current being applied for six minutes to both temples at first, then to one eye, and to the back of the neck, and lastly to the other eye and the back of the neck, S. immediately rose to $\frac{8}{200}$, and by May 21st had improved = $\frac{16}{200}$. On the 21st, patient left my office between 3 and 4 P.M., and while in the street she became blind, so that she had to be led home by strangers. (On this day, contrary to her custom, she had come to my office without escort.)

She was brought to the office immediately after, but not finding me in, returned the next morning at eleven o'clock, when I found her sight reduced, as usual, to quantitative perception of light. The use of the current in the manner last mentioned raised S. to $\frac{12}{200}$ immediately, and to $\frac{20}{200}$ by May 27th. In the mean while I had ordered preparations of iron internally, warm baths for the body, and douches to the head, by which treatment she seemed to be benefited materially.

Her condition remained the same until June 7th, when she awoke with her sight, but lost it shortly after leaving her bed. On the evening previous, she had been playing actively with other children. She came to me at 11 A.M., and having been electrized as usual, she counted fingers at six feet. In a few days S. was restored $= \frac{20}{100}$. After this experience, I ordered tonics, frequent baths, and absolute mental rest for patient, besides warning her against violent exercise and overheating.

There were no relapses until October, 1875, when a slight exertion produced total blindness. Her usual visual condition was restored by the use of electricity for three consecutive days. The same thing occurred once more in January, 1876, since which time patient has been doing well, retaining S. $= \frac{20}{100}$ with a glass $+ \frac{1}{8}$.

For the etiology of this case, I can hardly offer an explanation. From the more frequent causes, however, of the loss of sight, it seems at least probable that determination of blood to the brain was a pathological factor. With each attack I was forcibly reminded of the "recessus" described by Michel (cf. Graefe's Arch. f. O., vol. XIX., A. 2, p. 81). This recessus is of special importance, from being in contact with the upper surface of the chiasm, and in direct communication with the lateral ventricles. For it is very conceivable that in this case fluid collected in the ventricles in larger amount, and under increased pressure. Entering the recessus, it may have compressed the chiasm, and thus temporarily destroyed the power of transmission in all its fibres.

6. *Embolism or Hemorrhage of the Arteria Centralis Retinæ.*

Mrs. A. F. Z., aged 32, has had five children, and is now in the third month of pregnancy. On the 25th of January, when just commencing to knit—she had not been knitting for four days—patient noticed that she was unable to see at all with her right eye, and not as well as usual

with her left eye, in consequence of which she consulted me on January 26th. Externally the only change perceptible in either eye was a slight dilatation of the right pupil, which also seemed to react more slowly than the left. Acuteness of vision: left eye $\frac{20}{20}$; right eye, $\frac{6}{200}$. With the right eye, patient was barely able to count fingers at eight feet, whilst she saw better with peripheral than with central portions of the right retina. Intraocular tension was normal in both eyes. Ophthalmoscopic examination in the inverted as well as in the direct image disclosed a light, whitish cloud on the optic disk itself, and on its circumference, extending here and there over the margin of the disk, especially in the direction of the macula lutea, thus imparting to some of the blood-vessels a veiled appearance. Veins in part very full, arteries very empty; the whitish stripe on them perceptible at some distance from the papilla; but also a number of veins, thin and rather empty of blood, at or even near the margin of the disk, and several arteries on and near the papilla hardly perceptible.

At the site of the macula lutea an oblong, oval spot, the longer axis of the oval being vertical, about one-fifth the size of the disk, of an intense cherry-red color with well-defined edges. Color of surrounding part of fundus not changed. Numerous minute branches of blood-vessels can be traced to the edge of the spot, in the centre of which an extremely small, whitish dot is to be seen.

Patient being a very nervous, hysterical person, afflicted from time to time with palpitation of the heart, headache, pains in the stomach, etc., she was admitted to my private clinic, and after a single artificial extraction of blood from both temples, was subjected to a course of treatment with tonic and anti-hysterical remedies. After dilating the right pupil with atropine, I examined her thoroughly with lenses of different power, both in the inverted and in the direct image, making a copy of the fundus. Whilst examining in the upright image I could positively exclude the possibility of the cherry-red spot being an appearance produced by contrast, for the fundus in the vicinity of the spot was of the same color as of the other portions, as well as of the background of the left eye. Besides, three days later, the spot was plainly seen to be sharply defined at all points, excepting below, where, like a hemorrhage of the retina, it commenced to lose itself in the retinal tissue—an appearance which became more and more marked in subsequent examinations. Hence I could already make the diagnosis of a hemorrhage at the macula lutea, which, to judge from the color, was probably venous and not

arterial. Venous pulsation was not noticed at any time, though the veins seemed to be unequally filled at different points of their course. The whitish dot in the centre of the macula lutea and of the cherry-colored spot was not isolated, for I repeatedly observed five similar minute points near it.

Patient was also suffering from considerable hypertrophy of the left ventricle. The precise time at which loss of sight had occurred could not be determined.

On February 20th, patient was discharged with $S = \frac{20}{20}$. At times, as she stated, a cloud would float in front of the letters she was reading, but it was already becoming so thin that she could almost read through it. The oblong spot, which she had been noticing as a central scotoma, now seemed to her to have lost its uniform aspect and to be divided into two equal parts.

At this time and subsequently, as long as traces of the spot could be recognized with the ophthalmoscope, patient declared that, when she kept her eye steadily fixed on a letter, the spot would move rapidly with an oscillating motion or suddenly dart away. At first I thought that this remarkable appearance was due to the circulation and coincident with the arterial pulse ; but found that this was not the case, and indeed do not yet know how to explain this phenomenon.

The gradual changes observed with the ophthalmoscope were the following : The whitish cloud on and around the disk was discernible several weeks after patient's discharge. Arteries and veins remained less full than on the left side for some time. The cherry-colored spot in the macula lutea had gradually become less distinct, and diffused into the neighboring retinal tissue during patient's stay in my private clinic. Its color became less marked and the white dot in its centre disappeared. On the day of patient's discharge it had divided into an upper and a lower half, corresponding to the statement of the patient herself. Eight days after her discharge, though the subjective appearance had not changed, the ophthalmoscope could only detect a narrow, vertical grayish-white stripe at the site of the spot.

Patient did not return to be examined, so that the final conditions or the " restitutio at integrum " have not been determined.

7. *Acute Idiopathic Cyclitis in the Left Eye, and, some Weeks later, in the Right Eye.*

Dr. F. in K., 32 years of age, a country physician, over six foot

high, rather thin but of perfectly healthy parents. Until the autumn of 1871, he had not been subject to any severe disease. In November, 1871, while going to see a patient, he fell, breaking the inner condyle of the left knee. The ligamenta interna and several muscles were lacerated, and profuse hemorrhage took place into the joint. He was confined to his bed for a long time, and, as he relates, "after many orthopædic and calmotherapeutic attempts at cure had been undertaken, I finally recovered, after years, with a deflection of the knee inwards, and loss of motion and weakness in the joint. This did me a great deal of harm, reducing me both physically and mentally, so that I became very susceptible to the dampness and cold of our house, which we at last left in the spring of 1876." Our colleague then suffered from the following diseases :

1875, January, Acute articular rheumatism with cardiac complication.
October, Acute abscess of the middle ear.
December, Acute pleurisy with exudation on the left side.
1876, January, Acute cyclitis on the left side.
April, Subacute rheumatism in the muscles and joints.
June, Acute cyclitis on the right side.

From all these acute disorders he recovered without permanent evil results. "In the intervals," he continues, "I was plagued by acute bronchitis, laryngitis, coryza, gastritis, and enteritis—troubles to which I had previously been an entire stranger. Between my fall (November, 1871) and the first acute attack of rheumatism (January, 1875), you must picture me as suffering from time to time with one of these lesser evils just mentioned." My colleague having consented to my using his communications, both written and oral, I will reproduce his own description of the different attacks of cyclitis which he underwent.

"In the first days of the year 1876, I occasionally felt pain in the left eye, which I noticed was very tender whenever it was accidentally touched or the lids firmly closed; but I paid no further attention to the matter, although, about the middle of January, I noticed a point of injection in the sclerotic. The night of the 19th to the 20th of January was the first in which I passed many sleepless hours. I understood the significance of this fact, and on examining the eye carefully on the morning of the 20th, I found nearly the entire scleral conjunctiva markedly injected. Iritis ! I said to myself, and immediately dropped a solution of atropine into the eye. The pupil was soon dilated ad maximum. I felt relieved

and went back to the cold, damp room where I was wont to put up my own prescriptions."

On January 22d, F., who still continued practising, came to Berne on account of a case of illness in his family. He came to seek my advice, after each successive night had brought him more pain and less sleep, and the remissions during the daytime had become less frequent. In the evening, between seven and eight o'clock, when the patient presented himself to me, he was suffering excruciating pain in the left eye. The amount of photophobia which he displayed was marvellous. He held his hands or his handkerchief before the eyes and shrank back from even a suspicion of light. When the upper lid was touched, he experienced severe pain in the whole of the eye. Having gained a short glimpse of the eye by force, I found the pupil somewhat dilated, no discoloration or swelling of the iris, no exudation, aqueous humor quite clear. An examination with the ophthalmoscope was not possible. Conjunctiva of the globe somewhat injected on the nasal side, less so externally.

The tension seemed to be the same as in the other eye. On the nasal side of the ciliary region, pressure caused pain; on the temporal side, it produced the agonizing lancinating pain of cyclitis, which disease I did not hesitate to diagnose. I directed the patient to instil a drop of a solution of atropine sulphate into the eye three times a day, to apply iced rags to the eye for a quarter of an hour thrice daily, and to remain absolutely quiet in a dark room.

Patient did not return until the 25th, *i. e.*, three days later, having continued making professional visits during this time and complying to my directions only to a very limited extent.

When I went to see him, in the evening, he suffered such pain that the approaching a hand or walking rapidly through the room was misery to him. Patient stated that the eye still retained sight. On opening the lids, which was only possible for a single moment, the conjunctiva was seen to be much injected, moist and shining throughout, the pupil well dilated and regular, the aqueous humor only slightly opaque. Photophobia was excessive. I ordered rest in an absolutely dark room, three times daily a drop of atropine sulphate, and for the next morning a powder of calomel 0.1 internally. Patient described the night of the 24th to the 25th as follows: "The most intense boring and tearing pains, the other eye also very painful, unmistakable meningitic symptoms, retching, from time to time soporific condition. The subsequent nights

passed in the same manner. The only thought I could elaborate was on suicide."*

On the 26th, at noon, the pain had diminished, although severe attacks would recur from time to time. Slight œdema of the upper lid and chemosis conjunctivæ, aqueous humor less cloudy. Pupil equally dilated. Photophobia and sensibility to touch unchanged. Prescribed atropine as above. In the afternoon, one calomel powder, four leeches to the left temple. In the evening, photophobia was less marked; spontaneous pain less and of rare occurrence.

On the 27th, the condition of patient had not changed materially, except for the disappearance of the conjunctival chemosis. During the next two days, the eye was covered with iced rags a quarter of an hour three times a day, with excellent results; photophobia, tenderness, and injection being markedly decreased. On the third day, lukewarm chamomile application having been tried for half an hour, at the request of the patient, and proving still more beneficial, they were employed for a number of days instead of the iced rags, but never longer than half an hour. By the first of February, pain had almost ceased, and in the third week photophobia, tenderness, and injection had become so light that the patient could leave the house; in the beginning, at night only; later on, in the daytime also, the eyes being protected by glasses of a dark smoke-color. On March 7th, patient thought himself well enough to return home in order to superintend his family moving into a new dry dwelling, but had to return to Berne the very next day with injection of the eye, photophobia, and tenderness. This relapse lasted about ten days, being comparatively "easy to bear," and patient did not leave Berne until April 17th, when he was able to enter his new dry house. After that he went on practising, "the weather being almost continually damp and cold."

"Already during the entire month of June, I noticed a short lancinating pain in the interior of the right eye whenever it was exposed to a

*"The description of my condition is not at all exaggerated. I write it weighing every word, and fully responsible for the truth of any and every expression used. If you will peruse the catalogue of diseases which I have suffered, you will see that I have some experience as regards pains; and as I have repeatedly been troubled with ingrowing nails and have borne toothache in all its phases (pulpitis, periostitis radicis, abscess, ten extractions), you can picture to yourself how terrible was the pain of this inflammation of the eye."

draught or had been used long. The sclerotic was white; there was no injection.

"On June 27th, after a sleepless night, the eye was found to be moderately injected. After instilling atropine, I immediately left for Berne. An acute cyclitis was now developed in this eye, which was, however, of less intensity than the first attack. For not only was there less pain, but the attacks of pain were shorter than the periods of tolerable ease, and consequently the only remedies needed were atropine and darkness."

The objective appearances in this eye were exactly the same as they had been in the left one. The eye, or rather the conjunctiva bulbi, was red throughout and slightly swollen, cornea and aqueous humor very slightly cloudy, pupil well dilated by atropine, photophobia and sensitiveness to touch very marked. Already in the course of three or four days nothing could be seen but a little pericorneal injection, which lasted until the end of July. Patient had not noticed any diminution of vision in either eye, until a few days ago he wrote to me, stating that he could not see quite as plainly with the right eye as with the left. In my last examination I determined S. $=\frac{20}{20}$ with E. o. utr.

The sufferings of our colleague must have been due to an affection of the ciliary body. For though the pain alone could be attributed to neuralgia, the injection of the conjunctiva, chemosis and œdema of the lids, with cloudiness of the cornea and aqueous humor, pointed distinctly to an inflammation. It was astonishing that there was so little pericorneal injection of the deeper ciliary vessels; also that the acuteness of vision did not suffer; lastly that repeated ophthalmoscopic examinations were negative in their results. Neither iris, choroid, nor vitreous body was affected at any time. The affection being thus limited to the ciliary body, was probably of rheumatic origin. Again it is remarkable that no exudations of any kind, such as are prevalent in the iritis of rheumatic patients, were observable.

MISCELLANEOUS COMMUNICATIONS FROM DR. HIRSCHBERG'S EYE-CLINIC.

By DR. PUFAHL, Clinical Assistant.

Translated by Dr. B. Bettman, of New York.

1. *Epicanthus and Determination of the Field of Fixation.*

Von Ammon has been the first to describe congenital epicanthus as a redundancy of skin on the root of the nose, and called A. v. Graefe's attention to the fact that the essential feature of the disease was rather an insufficiency of the oculomotor nerve than a redundancy of skin. Paralysis is not present in these cases, as diplopia has never been noticed connected with them. An absolutely symmetrical paralysis, moreover, can hardly be thought possible.

Consequently, the hypothesis seems admissible that, on account of the pathological drooping of the upper lid, which is produced by the redundant skin, the elevations of the eyes, as being unavailable, are left off, and that, on account of disuse, an insufficiency of elevation is produced. This hypothesis is supported by the fact that by ptosis operations and practice, the field of fixation can be augmented upward by several degrees (about 80).

As an explanation to the above, I will now give an account of three cases, but recently treated in Dr. Hirschberg's eye-clinic.

1. Miss A., a pianiste, came to the clinic February 8th, 1878, complaining of inability to read notes for any length of time, as the eyes became tired and the lids drooped. Upon examination, we found a slight degree of myopia, fair acuity of vision, no preponderance of

the externi, but a well-marked congenital epicanthus. Dr. Hirschberg utilized the opportunity to represent graphically the extent of the field of fixation, which has not yet been done in epicanthus. Schneller's method (Archiv f. Opth., XXI., 3) was employed. The head was fixed simply by a chin-supporter and two hands, the mouth-piece not being brought into requisition, and the measurement made on our blackboard, graduated in central projection. It was now shown that the field of fixation was normal in all directions, except upwards, where it extended only 26° above the primary horizontal position. The operation was performed by removing a crescent-shaped piece of skin from each upper lid. The redundant skin on the root of the nose was not excised, since experience teaches us that the removal of skin

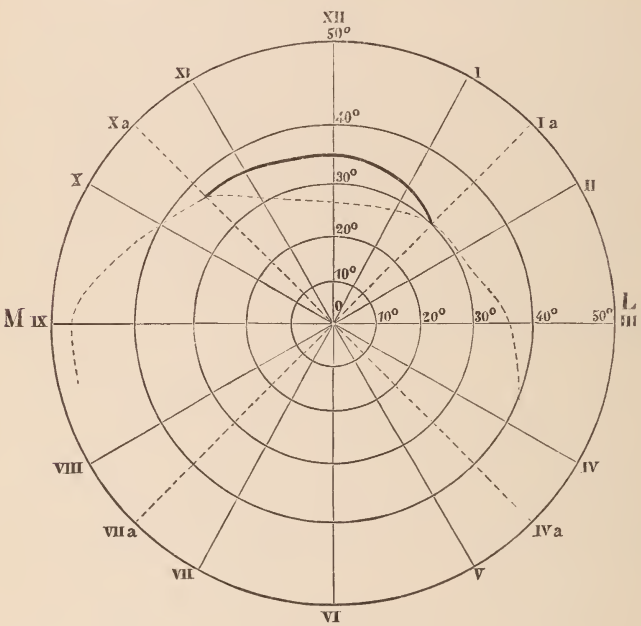


Fig. 1.

in that locality is not attended with particularly good results, and, on the other hand, the practical problem to be solved in the case was to enable the patient to play piano and read notes.

The complaints of the patient ceased after the healing of the wounds and several days' exercise.

A repeated measurement of the field of fixation showed an enlargement of 8° upwards, so that the field of fixation now reached to the 34th° above the horizontal primary position, as is to be seen on figure 1.

2. March 14th, 1878, Miss Z., æt. 25, presented herself at the clinic; she had been operated upon ten years previously at v. Graefe's Clinic. Scars were plainly visible on the root of the nose and at the outer angles of both eyes, the result of operations for blepharophimosis. The elevation of the lids and eyeballs was limited, so that the field of fixation extended upwards only 28° above the point of fixation of the primary position.

The distance between the inner angles of the eyes measured $37\frac{1}{2}$ millimetres; the width of the right palpebral fissure 23, of the left to 21 millimetres; the height of the palpebral fissure, at its middle, 4 millimetres; the breadth of the upper lid, in the primary position, 7 millimetres. The acuteness of vision was good. Myopia $\frac{1}{10}$.

In this case, as in the former, a small piece of skin was removed from both upper lids. In the course of a few days, the patient was able to bring the line of fixation 33° above the primary position. The breadth of the scar on the root of the nose, in this case, was a matter worthy of notice.

3. The enlargement of the field of fixation in the case of Carl B., æt. 20, who was admitted to the clinic May 9th, 1876, was also noteworthy.

The patient, who had been operated upon ten years ago by A. v. Graefe, showed scars on the lids and root of the nose, and an artificial widening of the external canthus on either side. A marked epicanthus and redundant skin of both upper lids remained, nevertheless, combined with diminished upward movement of the eyeballs, amounting to 12° in the right and 8° in the left. After performing a double ptosis operation, the line of fixation could be raised, in the right eye to 20°, in the left to 24°. See fig. 2, where the boundaries of the enlarged field of fixation are dotted.

In this connection, I may be allowed to mention that, immediately after the publication of Dr. Schneller's interesting article, (Archiv f. Ophth., XXI., 3) we applied his method of examination in several cases of paralysis of the ocular muscles. We

obtained very good results in cases of well-marked paralysis, but in cases of slight paresis, *e. g.*, of the superior oblique, it is often impossible to determine, with any degree of certainty, the impairment of motion of the affected eye as compared with the healthy eye, while with Dr. Hirschberg's graduated blanks we are enabled to make a diagnosis in these cases with ease and certainty.

With the aid of these blanks, we also obtain good results in cases of simulated one-sided amaurosis. A prism refracting vertically, and having a minimum deflection of 12°, is placed before the sound eye. The patient then states the number of lines (degrees) which he sees, between the two flames. The reader is aware that there are five (see the table of Dr. Hirschberg in Knapp's Archiv, IV.).

This can be easily tested by holding the prism before your own eye. If the trial with other prisms (a prism of 9 degrees produces a vertical deflection of 4°, and one of 16°, a vertical deflection of 9°) provides us with a positive result, then no doubt can exist as to its accuracy.

2. *On Iridotomy.*

P., æt. 26, was admitted to the clinic February 4th, 1878. Patient has had an eye-disease since his 20th year. Iridectomy had been performed five times in the right and twice in the left eye.

In the right eye, a continuous cicatrix, almost one line in width, was observed along the inner and lower corneal margin ; the iris was missing upwards, inwards, and downwards. A white membrane filled the pupil, and on the temporal side a square and stretched piece of iris-tissue was still visible. The eyeball was not irritable, and tension somewhat diminished. $S = \frac{1}{\infty}$.

The left eye showed numerous synechiæ at the pupillary margin, and a broad coloboma of the iris in the inner and lower quadrant ; the lens was opaque. Fingers were counted at 6 feet. Sn. XX. at 5 feet.

The right eye was in so hopeless a condition that no one would have undertaken an operation, had the left eye been sound. But as the vision of the latter was very much diminished, so much so that it was of no practical use, Dr. Hirschberg determined to risk an iridotomy in the right eye.

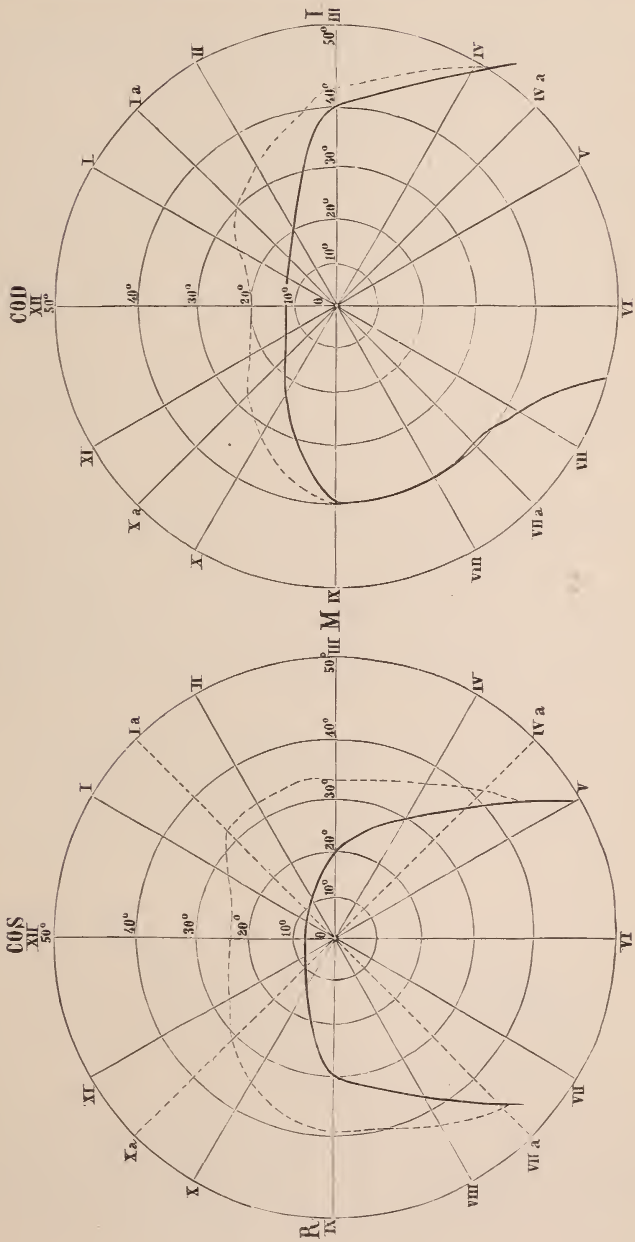


FIG. 2.

An additional iridectomy would not have yielded a good result. This could be foretold by the five previous operations and the great tension of the iris. But the more unfavorable the conditions are for iridectomy, the more favorable are they for accomplishing an iridotomy.

On the 3d of February, an incision with a lance-shaped knife was made downwards and outwards, and a little to the inner side of the corneal margin, penetrating the iris. With De Wecker's scissors a cut was effected obliquely through the iris and the thickened lens capsule.

The slit immediately gaped, and not more than a trace of vitreous was lost. The following day, the wound had healed without irritation, and the prolapsed vitreous could nowhere be seen. Feb. 11th, with + 2 patient read Sn. XX.; Feb. 21st, Sn. VI.; March 5th, Sn. IV.; March 30th, Sn. II., with + 3 Sn. LXX. at 12 feet. The acuity of vision of the left eye had diminished so much (fingers at $1\frac{1}{2}$ feet) that discission of the cataract was performed.

Not all cases of iridotomy can furnish so brilliant a result, since often an accompanying change in the vitreous does not admit of a satisfactory degree of acuity of vision, notwithstanding that the perception of light and the projection are sufficiently good to warrant a successful operation. Such a result, even in exceptional cases, is to be hailed as a progress in science.

De Wecker's scissors are very valuable, but would be more so, at least for operations, if they were furnished with the handle of Cowell's scissors, which, as is known, consist of two spring clasps, which, upon being pressed towards each other, close the scissors.

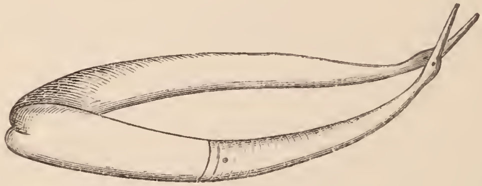


FIG. 3.

Fig. 3 is a sketch of the instrument modified by Dr. Hirschberg. This modified instrument is also exceedingly desirable for iridectomy; as any one can use it equally well with either

hand, the length of the handle allowing of its use across the nose without the least inconvenience.

3. *Pustula Maligna.*

The results of pustula maligna on the lids are more often observed in Berlin, on the persons of Russian hide-dealers; the disease but very rarely affects the inhabitants of our city.* Therefore I take the liberty to describe a case treated in Dr. H.'s clinic, which was under observation from the beginning of the eruptive stage until a cure had been accomplished.

K., a tanner, æt. 31, who had formerly been treated by Dr. Förster for inflamed eyes, was admitted to the clinic February 25th, 1878, with inflammation of the right eye, of four days' standing, and swelling of the lid existing since the last two days.

A large, reddish swelling of the upper lid was observed. The swelling was hard to the touch, and showed in its centre a yellowish spot $\frac{1}{2}$ inch long and $\frac{1}{4}$ inch wide. The eyeball was intact.

After making a deep incision, from which no pus escaped, the patient felt very much relieved. When he returned the next day, the swelling had increased, and the yellow infiltration had spread towards the median line of the lid, where a second swelling had made its appearance. An incision at this place was followed by a flow of dark blood. February 27th, the œdema had spread over the root of the nose as far as the inner side of the left lid. The right upper lid throughout its whole extent was of a bluish-red color, and hard to the touch. The yellow swellings were confluent, the incised wounds black. Excessive thirst, elevated temperature, and accelerated pulse. With these symptoms, patient was admitted to the clinic, and treated with poultices. On the evening of the same day, the patient's state of health had somewhat improved. The wounds were occupied by gangrenous scabs, and above both incisions a reddish zone of demarkation was already visible. Small blisters occupied the well-defined boundaries of the œdema on the nose.

February 28th.—Subjective condition passable, œdema of the nose had scarcely advanced. The blisters on the root of the nose resembled

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*Thielmann (Med. Zeitung Russlands von I., 1855) found in a collection of 352 cases only 2 in which the seat of the carbuncle was on the upper lid.

erysipelas bullosum ; the locality surrounded by the line of demarkation was insensible, the scab intensely black.

March 2d.—Gangrenous scab hardened and depressed, but not loosened at any part.

March 5th.—Diminution of the swelling ; a slight mobility of the upper lid plainly visible.

March 7th.—Scab becoming loosened from the inner side ; by spontaneous opening of the lids the eye was seen to be intact.

March 9th.—The mummified scab was detached at its edge, and was removed with the forceps without making any undue traction.

The underlying tissue was composed of a grayish, wavy mass, containing isolated reddish points, most likely commencing granulations.

Patient was discharged March 12th, but returned March 19th. The defect of the upper lid was closed, with the exception of a small triangular portion. The upper lid drooped as far as the centre of the pupil. The eye could be closed, although the upper lid lifted away from the globe in consequence of cicatricial contraction.

PERIPHERAL DIVISION OF THE CAPSULE.

PRELIMINARY COMMUNICATION.

BY H. KNAPP.

THE manifold reactive processes which, for years, I had observed to follow the extensive laceration or partial removal of the anterior lens capsule in extractions of cataract, processes described by me more or less in detail in Graefe's and these ARCHIVES, induced me, during the last seven months, to make experiments in a totally opposite direction, namely, in such a way as to reduce to a minimum the injury to the capsule, and, consequently, the reaction from it also, during the healing process of the extraction wound.

Above all, I endeavored to avoid the implication of a piece of capsule in the corneal section, and to that end opened, in the first nine operations, the capsule by a T-shaped cut.

After I had made an upper corneal section with a Graefe's knife, and had carefully removed a broad piece of iris, I divided the capsule with a sickle-shaped cystotome, near the upper edge of the lens, along the corneal section. Then I introduced the cystotome into the anterior chamber, and slit the capsule from the centre of the pupil straight upward to the edge of the lens. The exit of the cataract and the removal of occasional remnants of cortex were very easy. In this manner, from October 25th to November 14th, 1877, I operated on nine successive eyes. The recovery and visual results in every case were good. From that time I entirely omitted the vertical division of the capsule, which, in some cases, I had made larger, in others smaller, and confined myself to the horizontal section alone. In order to *cut* and not *tear* the capsule, I had very sharp cystotomes made, whose straight cutting edges* formed

* I prefer the straight to the sickle-shaped cutting edge, since it is very difficult to make a curved cutting edge perfectly sharp.

an angle of 120° to 150° with the stem, and drew the point through the capsule along the corneal section, without entering into the anterior chamber. I will here mention that the centre of the corneal section lay 0.5 to 1.5 mm. below the transparent corneal margin. During the division of the capsule, I pressed with the fixing forceps lightly on the globe, thereby making the corneal wound gap somewhat, which had the effect that the point of the cystotome could be easily passed through the capsule, which presented in the wound. The expulsion of the lens was as easy after this as after the T-shaped opening of the capsule, but decidedly easier than it commonly is after the central opening, if, in the latter case, an extensive horizontal division along the basis of the coloboma is neglected. From the beginning, A. v. GRAEFE has laid great stress on the horizontal section to insure an easy expulsion of the cataract, and ARLT, after having spoken of the extensive central opening of the capsule in his "Operations on the Eye" (Graefe-Saemisch, p. 300), quotes Graefe as follows: "v. Graefe, who used the cystotome only, has additionally made horizontal cuts along the upper equator of the lens, to overcome with certainty the obstacle which this part of the capsule, if undivided, is liable to offer to the edge of the lens while moving toward the wound." I have always followed this rule which, when a student, I learned by Graefe's impressive word and example. I should not omit here to mention a remark made by Dr. E. GRUENING, while assisting me in the extraction of a Morgagnian Cataract, in which the nucleus did not readily escape. He stated that, in a case of Morgagnian cataract which he had operated on lately, he had opened the capsule only at the periphery, having a double object in view—first, to prevent the nucleus from being caught in the peripheric pouch of the capsule; and secondly, to evacuate the liquid cortical substance directly, in order to avoid as much as possible the contact with the iris. So far as I know, no one except myself has confined himself to the horizontal section as a general method. Without previous intention, many operators, no doubt, have, like myself, in exceptional cases opened the upper part of the capsule only, when, on account of blood in the anterior cham-

ber, or of other conditions, the application of the spoon showed that the capsule of the lens had been opened insufficiently, or not opened at all.

Since the middle of November, 1877, I have in all extractions practised the peripheral section of the capsule exclusively, demonstrating the procedure and the course of healing to my pupils and some more experienced colleagues. Though the number of these operations, up to this date, May 17th, 1878, has not been very great, namely twenty-nine, yet the results they yielded appeared so invariable, and in part so unexpected, that I venture to publish this early preliminary notice of them, postponing detailed communications until I shall have tried the procedure on a more extensive scale.

I have performed the peripheral section sometimes with the cystotome, sometimes with Graefe's cataract knife, passing it in like manner through the capsule as before through the cornea; in the majority of cases, however, I have used the cystotome previously referred to, and as above described.

The results of my observations were as follows:

1. *The wound in the capsule united*—mostly during the first night—*in like manner as the wound in the cornea*, and could in some cases be demonstrated as a horizontal straight or slightly curved white line, apparently situated 0.5 to 1 mm. behind the iris. The capsular bag, thus again totally closed, stretched out as a plain, slightly lustrous membrane, which, by oblique illumination, could be demonstrated as soon as the anterior chamber was restored.

2. *Remnants of cataract, if there were any, lay shut up in the capsular bag, and, what is very remarkable, were gradually absorbed in the same manner as when the capsule is opened.* In the centre they always disappeared, whereas in the periphery a portion of them frequently remained. I mention, however, that only in a few cases notable remnants of cataracts were left, since, as above stated, the total removal of the lens proved quite easy.

3. *The irritative symptoms on the part of the iris were either exceedingly slight, or, in the great majority of cases, totally absent.* On the second or third day after the operation, the pupil was

invariably found wide and regular, commonly the iris had preserved its lustre and color, and a very faint circumcorneal injection was present. In some cases, however, hyperæmia of the iris with moderate circumcorneal injection was observed. In two only there was a filiform adhesion of one sphincter edge to the capsule. The hyperæmia of the iris was caused by implication of the capsule and iris in the angles of the wound. Plastic or suppurative iritis, pseudo-membranes in the pupil, drawing upward of the iris, capsulitis, and cyclitis did not once occur after the thirty-eight operations. Of the accidents during the operation I noticed hemorrhage,—without consequence—several times, and prolapse of vitreous twice. I here include the nine cases of ⊤-shaped opening of the capsule, since in all of them the horizontal section was longer than the vertical, and, in all cases, the capsule was closed by application of its anterior half to the posterior. The vertical rent was seen in the upper pupillary space either as a straight or irregularly linear scar which, in some cases, however, gaped somewhat on account of a retraction of its edges.

4. *In some cases the capsule cleared up completely and stretched evenly across the pupillary space; in the majority of cases, however, the capsule showed a slight, vertically parallel wrinkling,* proceeding from the horizontal scar. In the cases of the ⊤-shaped opening of the capsule, the corrugation radiated from the vertical line of the scar.

5. *Two cases were lost by primary suppuration of the cornea, exhibiting the so-called ring abscess, and a third case was lost by suppuration of the vitreous.* One of the first two cases showed beginning cataract complicated with disseminate choroiditis in the fellow-eye; the other case was complicated with dacryocystitis and inverted eyelashes on the upper lid. In this case the healing progressed favorably until the fourth day, when the corneal edge of the wound began to be white and thickened. The third case was likewise complicated: patient decrepit, cataract hypermature. Immediately after a regular corneal section, the evacuation of the anterior chamber was followed by the escape of fluid vitreous, which was increased during the

excision of the iris, so that the slightly dislocated lens had to be removed with the spoon.

In all the other cases the recovery was undisturbed and perfect.

6. Among the thirty-eight cataracts, there was a considerable number *complicated* with extensive posterior synechiæ, advanced sclero-choroiditis posterior, atrophic choroiditis, dirty-looking iris with insufficiently dilatable pupil, etc. Thirteen of the patients were over seventy years old.

7. The *visual results*, on the whole, were as good as those obtained after central opening of the capsule. One case even showed $S=\frac{20}{20}$ a few weeks after the extraction, and still remains so—four months later—despite some vertical wrinkling of the capsule. $S=\frac{20}{70}$ was the most frequent primary result. By this method, as by the ordinary one, the visual acuteness increases for some months after the operation; in no case have I seen it grow worse than it was at the time of the patient's discharge.

In comparing the advantages of the peripheral opening of the capsule with its disadvantages, there is but one disadvantage to be mentioned, and that one deserves due consideration; namely, that many cases require a subsequent central division of the capsule in order to obtain perfect vision. I have made this subsequent division of the capsule, as I did years ago in secondary cataracts, mostly with a sickle-shaped or broad needle, Graefe's retina needle, cutting a ⊥-shaped opening in the capsule, the horizontal line being at the lower margin of the pupil. I performed this little operation always by oblique illumination in a dark room. When the patient lived at a distance, I did it as early as two or three weeks after the extraction; when he lived near by, I often postponed it from two to six months, sometimes even longer. The centre of the pupil became perfectly and, so far as I could judge, also permanently black. The reaction from the after-operation disappeared in from two to five days, and in no case was followed by inflammation or unfavorable consequences. This issue might be anticipated on account of the absence of inflammatory products in the pupillary space.

Among the manifold *advantages* of the peripheral division of the capsule I will mention :

1. *Simplification of the operative procedure.* The instrument used in opening the capsule need not be introduced into the anterior chamber, since the capsule can be incised from one end of the coloboma to the other, by passing the point of the cystotome along the corneal section.

2. *The operative manipulation is less liable to do injury* than in the ordinary procedure, which requires an extensive laceration of the capsule within the anterior chamber, to say nothing of scratching of the cornea and iris, dislocation of the lens, and other accidents.

3. *The rapid healing of the linear wound of the capsule confines whatever remains behind, within a closed cavity, thus placing the eye, from which a cataract has been removed, in conditions akin to those which follow a simple iridectomy,* and this seems to me the chief advantage of the peripheral capsulotomy. The elimination, or even the diminution, of the dangerous consequences resulting from the permanent laceration of the capsular sac, the irritation caused by the shreds of capsule, the proliferation of the intracapsular cells, and the swelling of the remnants of cataract, do, I think, more than outweigh the necessity of the comparatively harmless subsequent opening of the centre of the capsule. The number of operations I have performed in the manner above described is still small, so small that an opinion as to the value of the proposed modification would be premature ; but if further experience only partially justifies my impressions, I think that the peripheric capsulotomy may lessen the danger still attending Graefe's method of extraction, by reducing the frequency and severity of iritic, irido-capsulary, and irido-cyclitic processes. How frequent and dangerous those processes are—and I should add the sympathetic ophthalmia which sometimes follows the peripheric linear extraction—every oculist knows, not only by his own observation, but also by the animated discussion of the numerous secondary operations—for instance, iridotomy—that have been resorted to in treating them.

NEW YORK, May 20, 1878.

OPHTHALMOLOGICAL REVIEW.

By H. KNAPP and E. GRUENING.

1. (*a.*) Becker, Otto, in Heidelberg. Atlas of the Pathological Topography of the Eye. I. Part, 1874; II. Part, 1875; III. Part, 1878. Published by W. Braumüller, in Vienna.

(*b.*) Pagenstecher, Herm., and Genth., C., of Wiesbaden. Atlas of the Pathological Anatomy of the Eye. 1875, published by W. Kreidel, at Wiesbaden.

(*c.*) Schiess, H., of Basel. Diseased Eyes in Thirty Pictures.

2. Pause, C. H. On the Nerves of the Iris. *Graefe's Arch.*, XXIII. 3, pp. 1–24.

3. Capranica, Stefano. Chemico-Physiological Investigations on the Coloring Substances of the Retina. *Arch. f. Anatomie und Physiologie*, 1877, p. 283. Abstract in *Klin. Monatsbl.*, April, 1878, p. 177.

4. Tweedy, John. Mydriatic and other Topical Effects of the Application of Gelsemina to the Human Eye. *London Lancet*, N. Y. Reprint, Septbr., 1877, p. 409, etc.

5. Kuester, F. On the Post-mortem Appearances of the Eyeballs and their Appendages in a Case of Argyria. Abstract in *Klin. Monatsbl. f. Augenh.*, Feb., 1878.

6. Horstmann, L. On the Disturbances of Vision after Loss of Blood. *Klin. Monatsbl. f. Augenheilk.*, April, 1878.

7. Lubinski, Dr. Three Clinical Observations in the Ophthalmic Service of the Marine Hospital at Cronstadt. *Klin. Monatsbl. f. Augenhk.*, April, 1878.

(*a.*) A Case of Glaucoma permanently cured by Spontaneous Dislocation of the Lens.

(*b.*) Primary Syphilitic Ulcer of the Eyelid.

(*c.*) Atrophy of the Retina and Disk following Facial Erysipelas.

8. Ayers, S. C., of Cincinnati. Ophthalmia Neonatorum. *Cincinnati Lancet and Observer*, Jan., 1878, p. 27.

9. Smith, F. W., of San Francisco. Clinical Notes and Observations on Ophthalmology.

10. WEBER, ADOLPH. The Cause of Glaucoma. *Graefe's Arch.* XXIII. 1, pp. 1–91, 1877.

11. MAGNUS, H. Embolism of the Central Retinal Artery or Hemorrhage in the Optic Nerve. *Klin. Monatsbl. f. Augenhk.*, Feb., 1878.

12. KRIES, N. V. Operative Cure of Three Cases of Paralysis of the Superior Oblique. *Graefe's Arch.* XXIV., p. 148

13. THOMPSON, J. L., of Indianapolis, Ind. Extraction of Fifty Lenses through a Straight Section of the Cornea. *American Practitioner*, 1878, pp. 168–176.

1. The work of Schiess contains thirty pictures representing some of the striking pathological alterations of the human eye, in cleanly executed wood-engravings, four times the natural size, with short descriptions of the history of the cases and the macroscopic and miscroscopic conditions of the specimens. Without aiming at completeness, Dr. Schiess has offered in this little volume to the student of ophthalmology a number of valuable illustrations of a part of the pathological material of his own practice.

The atlantes of O. Becker and Pagenstecher-Genth are very extensive and of fundamental importance. That of Becker represents in large drawings the varied pathological changes which the human eye undergoes. The principal aim of the author has been to exhibit the topographical relations of the alterations in the interior of the eye in such a way as to aid the practitioner in making anatomical diagnoses of the living diseased eye. He points out that with such an external habitus, *i. e.*, such clinical features, certain internal changes are connected which the physician, though unable to make out by physical examination, may expect from being familiar with analogous cases of which the author gives both the history, and the representation and description of the specimens. The plates are furthermore destined to be used for demonstration in classes of students both in didactic and clinical teaching. They are all drawn from nature by Drs. C. and J. Heitzmann, and admirably executed. They represent selected specimens of the ophthalmological museum of the University Ophthalmic Institute at Heidelberg, which, by the untiring efforts of Professor O. Becker, has become one of the largest and most instructive in the world.

The first plates show the macroscopic and microscopic alterations following the extraction of cataract, scars in the cornea, changes in the

capsule and iris, incarceration of iris and capsule in the scar, detachment of the vitreous, adherent leucoma and staphyloma, iritic, cyclitic, and keratitic processes. Nothing could give a clearer idea of these conditions and be more suggestive of practical application than the plates V. to IX. of the first part. Plates X. and XIII. illustrate suppuration in iris, ciliary body, and vitreous. On plate XI. is a beautiful drawing of a granuloma iridis. Then follow different anomalies in the shape of the crystalline lens (coloboma, etc.), cyclitic processes from foreign bodies and other causes, staphyloma, neuro-retinitis, and tumors. The third part, which has just appeared, contains on eleven admirable plates intercalary staphyloma, secondary glaucoma, cysticercus, iridocyclitis, detachment of the retina, ossification of the choroid, calcification and development of blood-vessels in the lens, iridocyclo-choroiditis from a foreign body, and of traumatic origin (plate XXVII. highly instructive), metastatic irido-choroiditis (plate XXVIII.), chorio-retinitis, and secondary cataract.

The work will be continued, though not entirely after a regular systematic plan, yet so that kindred subjects are put together, and certain groups of diseases are illustrated in their different aspects and phases.

The atlas of Pagenstecher-Genth consists of thirty-eight steel and copper plates of superb and, in medical bibliography, unparalleled execution. It treats the whole pathological anatomy of the eye in a systematic manner, containing a great deal more subject matter than Becker's work. The text is in German and English (by W. R. Gowers, M.D., of London), and gives, besides a sketch of the histories of the cases, a concise and purely objective description of each specimen. It would require only some additions in the text, and the work of Pagenstecher-Genth and the Atlas could be considered and used also as a complete systematic treatise of the pathological anatomy of the eye. This work is not only an ornament to every medical library, but also an indispensable guide to every oculist who wishes to follow the scientific development of ophthalmology, and who has the true progress of his profession at heart.

2. Pause examined the nerves of the iris in birds, mammals, and man, and represents their arrangement by three plates. He found in the iris only opaque nervous fibres, and followed them from the periphery to the sphincter, where they still were joined together in relatively large branches, without showing a terminal network of single fibres. He thinks it very probable, however, that in their further course the fibres

lose their marrow sheaths, and then, no longer being affected by the means of tinction, become indiscernible. The quantity of nerves of the iris greatly varies in different animals, and seems to be in direct ratio to the development of the muscles of the iris. Birds showed the greatest supply, man the least. All coarser branches lie in front of the blood-vessels. A distinction between motory, sensitive. and secretory fibres could not be detected.

3. Among the coloring substances undergoing absorption by light, one is contained in minute drops of some oily substance found in the eyes of the vertebrates. Among fish and mammals these oil drops are met with exclusively in the hexagonal epithelium cells, together with granular pigment. In reptiles and birds, however, they are never found in the pigmented cells, but always at the points of contact of the outer and inner portions of the rods and cones. In the amphibious animals, they are met with in both the above-mentioned situations.

The author has experimented with this substance, which Boll regards as the material from which the exhausted red coloring matter of the retina is regenerated; chiefly devoting himself to its chemical analysis, and has succeeded in demonstrating that it is identical, as far as its characteristic chemical reactions are concerned, with lutein.

Of the many micro-chemical tests to which the substance in question was subjected, three were found to be quite characteristic: 1. Concentrated sulphuric acid causes the golden yellow color of the drops to change at once to a magnificent deep violet, which soon assumes a deep blue color. 2. Concentrated nitric acid causes the drops to assume a momentary bluish-green hue, after which they immediately become colorless. 3. Iodine in solution causes the drops to assume a beautiful green tint which subsequently turns bluish-green. These oil drops, although never entirely separable from fat and cholesterine, further coincided in point of solubility and spectroscopic appearances with lutein.

The writer particularly remarks the photo-chemical sensitiveness of the substance, that is, its rapid and complete loss of color on exposure to light.

Lutein, a substance known to chemists since 1866 as a special animal coloring matter, occurs in the corpora lutea of quadrupeds, in the blood-serum, in the cells of adipose tissue, in the yellow fat of milk, and the yelk of the egg. In plants it is found in the seeds, in the skins and

meat of berries, in roots (yellow turnips), in leaves, and in the blossoms of a considerable variety of plants.

Hoppe-Seyler first called attention to the fact that lutein would lose its color on exposure to light; but the degree of sensitiveness to light manifested by lutein seems to vary according to the material from which it is derived. Thus, a solution of the lutein of the corpora lutea was found to lose its color, on exposure to sunlight, in a much shorter period of time than a solution of the oil drops. On the other hand, the coloring matter contained in the yelks of hens' eggs is not as rapidly acted upon as the lutein found in the corpora lutea of the cow.

The percentage of fatty constituents contained in the lutein, which have heretofore not been entirely separable from it, seems to stand in inverse ratio to its sensitiveness to light. As the lutein grows richer in its fatty constituents, its sensitiveness to light diminishes progressively, and vice versa. The solution of the retinal oil drops may be ranged midway between the extremes of sensitiveness.

The author concludes with the assertion, which he hopes to prove more conclusively at some future time, that possibly erythropsine differs only from its mother substance, lutein, in being in a state of finer, and photo-chemically more sensitive, subdivision.

4. J. Tweedy made experiments with a weaker (gr. iv. ad ℥ i.) and a stronger (gr. xxiv. ad ℥ i.) solution of the *hydrochlorate of gelsemina*. Its instillation into the conjunctival sac caused a deep-seated circumcorneal hyperæmia, dilatation of the pupil, paresis and paralysis of accommodation, and weakness of the external rectus muscle. The circumcorneal injection disappears when the pupil dilates. The dilatation begins twenty to forty minutes after the first application, and requires fifty to seventy minutes to become complete. "To insure paralysis of accommodation within three hours, a solution of at least eight grains to the ounce must be used every fifteen minutes for the first hour, and every half-hour afterwards." Weaker solutions dilate the pupil slowly, and weaken the accommodation without paralyzing it. The weakness of accommodation disappears first, in six to twelve hours; the dilatation of the pupil lasts longer, one or several days.

The author thinks that gelsemina has a *specific action on the sixth pair*, diminishing the power of the external rectus muscle. He ascertained this fact as Ringer and Mursell did before him, by testing the power

with which, before and after the application of gelsemina, the eye could overcome prisms.

From J. Tweedy's communication we may infer that gelsemina is a mild mydriaticum, the action of which is slower, weaker, and more transient than that of atropia. The circumcorneal injection—of which, however, no unpleasant effects are mentioned—is, perhaps, only due to irritant qualities of the preparation, and not to the remedy itself.

5. The author, referring to the case of argyrosis observed by B. Riemer, publishes the results of the microscopic examination, in this case, of the eyeballs and lids.

The investigations of Riemer show that the silver introduced into the system may be detected in the form of small, rounded granules in the connective tissue throughout the body.

The special researches of Küster have corroborated this fact in regard to all the connective-tissue structures of the eye, with the exception of the cornea, and of the connective tissue of the nerves and retina.

The presence of silver was demonstrated in the sclerotic, the dural sheath of the optic nerve, the tunica propria of the conjunctiva, the subconjunctival connective tissue, Tenon's capsule, the tendons and the interstitial connective tissue of the muscles of the eye. Everywhere the silver was found in the connective-tissue cells.

The presence of the silver in the uveal tract and the ciliary muscle could, however, not be demonstrated with the microscope, owing to the pigmentation of these structures.

Generally speaking, the most vascular parts were found to contain the largest quantities of silver. Thus, for instance, the outer layers of the sclerotic, which are less dense and more vascular than the inner layers, were more richly impregnated with silver than the latter. The granules were found singly along the capillary vessels, occurring in their walls, especially in the nuclei ; they were entirely absent in the veins.

Thus, all those structures of the eye that are not directly nourished by blood-vessels are found entirely free from silver. Among these are classed the corneal tissue, the lens with its capsule, the zonula, the vitreous humor, and the epithelium of the cornea and of the conjunctiva. The optic and ciliary nerves and the retina, with their blood-vessels, were also free from silver.

The central artery of the retina, especially, was carefully traced and examined in every part, from its entrance into the optic nerve down to its minutest ramifications in the retina, with entirely negative results.

With reference to this point, therefore, the retina shows an analogy with the organic centres of the nervous system, as Riemer could not detect the presence of silver either in their nerve-tissue, connective tissue, sheaths, or even the connective tissue of their vessels. The innermost layer of the dura-mater sheath of the optic-nerve trunk showed some features of special interest, the presence of silver being perceptible to the naked eye in the shape of a silvery seam marking the boundary line between the connective tissue and its investing endothelium.

The endothelium seems actually to oppose an insurmountable barrier to the advance of the silver pigmentation.

As regards the eyelids, nothing special need be said; all parts contained silver granules in equal proportion.

The Meibomian glands were affected in a manner similar to that of the sebaceous glands of the cutis.

The pigmentation was intensely marked in the excretory ducts of the Meibomian glands, entirely wanting in the acini.

The transverse section of every terminal acinus showed a narrow, moderately pigmented seam. On the basis of his microscopic preparations, the author maintains the existence of a membrana propria of the acini, contrary to the views of Waldeyer.

6. The author publishes six cases of the above-mentioned affection with remarks. Sudden disturbance of vision, generally involving both eyes, has occasionally been noticed to follow profuse hemorrhages, especially hæmatemesis and metrorrhagia. This failure of sight rarely ensued immediately after the hemorrhage, but generally from the third to the fifth day, in the majority of cases leading to incurable amaurosis.

In the six cases under consideration, the usual defect appeared from the third to the eighth day; in three cases it resulted in complete amaurosis within a few hours. In the first case, normal acuity of vision was restored, but a permanent limitation of the field remained. In cases 3 and 4, considerable weakening of sight, with limitation of the visual field, resulted. The ophthalmoscopic examination of cases previously reported was either negative or revealed atrophy of the optic nerves. The latter condition was demonstrated in three of H.'s cases, which were, however, not examined until after a long period had elapsed. The other three cases were examined shortly after the occurrence of the hemorrhage, revealing the inflammatory appearances of a neuritis, and

subsequently, when all inflammation had abated, a whitish discoloration of the optic nerve.

The writer cites 39 cases of amblyopia and amaurosis following loss of blood, collected by Fries, of which number 26 were the consequence of hemorrhage from the intestinal tract, 9 followed metrorrhagia, 1 hæmoptysis, 2 epistaxis, and 1 hemorrhage from the urethra. H. excludes the last 4 cases, on the ground that their connection with the hemorrhage is not shown, thus reducing the number to 35, to which he adds a case observed by Leber and his own cases, making an aggregate of 42 cases. The cause of the visual affection was hæmatemesis in 31 cases, metrorrhagia in 12. The trouble never began immediately after the hemorrhage, but in periods varying from 1 to 14 days thereafter. Permanent amaurosis resulted in 21 cases; in 6 cases, there was amblyopia on one side, and amaurosis on the other; bilateral amblyopia was recorded in 9 cases; amaurosis of one eye, the other remaining perfectly normal, in 2 cases, and complete restoration of sight in 4 cases. In almost every case there was also a limitation of the visual field.

An ophthalmoscopic examination was made in 35 out of the 42 cases, but in 25 it was not resorted to until 4 weeks or more had elapsed; of these, in 22 cases atrophy of the optic nerve was indicated by discoloration, associated with narrowing of the vessels. In the remaining 3 cases the examination was negative.

Of the 10 cases examined within a week or so of the accident, inflammatory affections of the optic nerve were present in 6; in 3, the fundus evidenced incipient atrophy of the optic nerve, and in 1 the examination was negative.

In all the cases under close observation from the commencement, neuritis was present, from which fact the writer deduces that the disturbance of vision and the intraocular changes following loss of blood are due to inflammation of the optic nerve, resulting in atrophy. He does not consider the affection attributable to anæmia of the optic nerve or its centres, because a variable period always intervened between the hemorrhage and the deterioration of sight, but to secondary pathological changes in the optic nerve. He sustains his view by the fact that in many cases the hemorrhage was too inconsiderable to cause marked anæmia, and again, in several cases, after vision had begun to improve, hemorrhages recurred, without at all interfering with the improvement.

H. neither advances any new theory in regard to the original causation of the ocular affection, nor does he accept Samelsohn's hypothesis (based on the investigations of Schwalbe and others), and concludes with the suggestion that a careful functional examination of the remaining cranial nerves in such a case might throw additional light on the matter.

7 *a*. Patient, male, æt. 74, was admitted March 10th, 1876, suffering from an acute exacerbation of a chronic glaucoma of the left eye. Palpation showed extreme tension of the globe and almost entire loss of sensation of the cornea ; the anterior chamber was very shallow, the iris was closely approximated to the cornea, the pupil dilated and several scleral vessels tortuous and elongated. The opacity of the refracting media of the eye rendered an ophthalmoscopic examination impossible. Patient was urged to submit to an immediate operation, but refused. The following night pain set in as usual, but after a time it ceased suddenly and the patient slept soundly.

Examination of the eye on the following day revealed considerable deepening of the anterior chamber, tremulous iris, and a return of the normal tension of the globe. Focal illumination showed a displacement downwards of the lens and of the adherent zonula Zinnii, which appeared as a semitransparent fringed margin. The superior margin of the lens had not settled down more than 2 mm. below the upper pupillary margin. Sight at once began to improve :—

Mar. 17th—L. E., M. $\frac{1}{4}$, S. $\frac{20}{100}$.
" 22d — " " M. $\frac{1}{4}$, S. $\frac{20}{70}$.
" 24th— " " M. $\frac{1}{4}$, S. $\frac{20}{50}$.

It cannot be doubted that the sudden disappearance of all the symptoms of glaucoma, the rapid improvement of vision, and the change from hypermetropia, which still existed in the R. E., to a high degree of myopia, was due solely to the displacement of the lens. Patient left the hospital and did not again come under observation for one year, when he stated that vision had remained good for only 1 month and then had gradually deteriorated, but without pain. Examination of the L. E. now revealed S.$=\frac{20}{40}$, not with concave, but with convex $\frac{1}{3\frac{1}{2}}$. The lens had become opaque, and had settled down further, so that the pupillary segment was broader. The refracting media had almost entirely cleared up, thus rendering the use of the ophthalmoscope possible, although only a limited view of the fundus could be obtained, the pupil being partially blocked up by the opaque lens. A distinctly

glaucomatous excavation of the disc could not be made out, but several vessels showed abrupt changes in their diameter at the margin of the disk, which was of a characteristic gray hue. A few floating shreds on the margin of the lens were all that remained of the zonula Zinnii.

b. Patient George S., age 30, sailor, was admitted to the hospital, presenting a small ulcer on the upper lid of the left eye. It was at first attended by moderate conjunctival reaction, which soon abated, leaving the ulcer steadily progressing. The sore was oval in outline, covered by a dry patch of false membrane, not sensibly elevated above the surrounding skin, showed no inflammatory zone and spread downward, involving the lower margin of the lid, denuding it of ciliæ. There was no pain. Patient persistenly denied the possibility of infection. Twenty-seven days after admission, the sore having meanwhile cicatrized under local mercurial treatment, a cartilaginous induration remained and glandular swellings developed about the left ear.

About the thirty-seventh day, a characteristic syphilitic roseola appeared on breast, neck, and parts of back, attended by painless imduration and swelling of the cervical, nucheal, and inguinal glands, and slight febrile action.

About the fortieth day, no lesion of the genitals having been discovered on admission, several scattered papular syphilides were found on glans and body of penis.

The interest of the case lies mainly in the unusual site of the initial lesion of syphilis and in the rare character of the latter, there being not more than ten cases of undoubted syphilitic primary ulcers on record.

c. Atrophy of the optic nerve and of the retina is one of the rarest consequences of facial erysipelas. The writer reports a very interesting case, in which he had the opportunity of observing certain inflammatory changes in the interior of the eye, during the continuance of the erysipelas. In the majority of cases heretofore recorded, the existence of erysipelas had only been determined by the previous history of the case.

The patient had been suffering from erysipelas of the face and other parts for several weeks. The first time he was able to open his eyes he found himself totally blind.

From this period until his death from a chronic pulmonary complaint, ten months later, he was under daily observation. An ophthalmoscopic examination revealed incipient atrophy of the retina and disk in the right eye, following neuro-retinitis ; in the left eye, acute neuro-retinitis

The writer observed this inflammatory condition closely during two weeks, noting every change, until, as a final result, atrophy of the retina and disk developed.

L. sums up as follows :

(1.) Atrophy of the retina, in this case, was undoubtedly caused by facial erysipelas.

(2.) The stage of atrophy in this class of cases is probably always preceded by a stage of acute inflammatory disease (of variable duration) of the retina and disk.

(3.) The pressure exerted directly by the inflamed orbital contents upon the optic nerve plays the most important part in connection with these intraocular changes.

8. Dr. Ayres dwells, in the fourth article on the above subject, on the imperative necessity and the invariably favorable results of an attentive nursing and rigorous treatment of ophthalmia neonati. Since the subject is of very great importance, we copy the plan of treatment, which under his and Dr. Aub's attendance is carried out at the Cincinnati Hospital.

The eyes are cleaned every hour or half-hour, or even oftener in cases where the discharge is very profuse, by gently separating the eyelids with the fingers and removing the accumulated pus with a soft rag or camel's-hair brush. A solution of alum, gr. ij. ad aquam ℥ ss. or of argent. nitr., gr. ij. ad aquam ℥ i. is dropped into the eye every hour or two.

Cold compresses are used in many cases. They are generally well borne and are grateful to the little patients. They must be changed frequently in order to accomplish any good, but care must be taken in delicate children not to abstract too much heat.

Every morning the eyelids are everted and brushed with a solution of argent. nitrat. grs. v. ad xx. ad aq. dest. ℥ i. according to the severity of the case, and the lids washed off with tepid water. Unless the swelling of the lids mechanically prevents it, the cornea is inspected *daily* in each case. As the case improves, the interval between the instillations of alum and argent. nitrat. is continued in a weaker or stronger solution, until every trace of the disease has disappeared.

The greatest stress is laid upon the thorough cleansing of the eye in the acute stages of the disease, and this is attended to, not only by day, but by night.

To this part of the treatment do we owe the immunity of the cornea

from ulceration. The pus is neutralized or coagulated by the action of the nitrate of silver and alum, and its corroding effects are thus prevented.

9. Dr. Smith reports (l. c., p. 71) a case of cysticercus in the anterior chamber. It presented a small cyst; was attached to the iris, and Dr. Smith was startled to see movements which, though slight, were quite discernible. After extraction, the hooks were plainly to be seen with a lens, the attachment of the iris was one line in width, the head, when extended, measured about two lines. Only a few cases of ocular cysticercus have thus far been observed in America.

10. A. Weber, for more than ten years, has made numerous experiments to investigate whether glaucoma was an inflammatory affection (von Graefe) or a neurosis (Donders). The experiments supported neither hypothesis. After a good deal of theorizing, he states that the cause of glaucoma is a mechanical one, impeded filtration of the humors of the eye, on account of the obstruction of Fontana's cavities. This obstruction is caused by swelling, engorgement, of the ciliary body compressing the circulus iridis major, and pushing the periphery of the iris forward and outward, so as to obliterate the system of small cavities lying at the periphery of the anterior chamber near Schlemm's canal, and known as Fontana's space. On examination of glaucomatous eyeballs, the above condition was found. From this point of view, an explanation both of the symptoms of glaucoma and the curative effect of iridectomy is attempted, but does not always appear very forcible. He mentions that he has not seen much good from iridectomy in glaucoma of young persons, all of whom, as far as he remembers, suffered from heart disease. In cases of malignant glaucoma, where the operation does not improve, but rather aggravates the disease, he presupposes the existence of a firm union between the periphery of the iris and the cornea. This may be assumed when, immediately after the operation, the tension of the globe is not materially lessened. In such instances W. advises to introduce a spatula into the periphery of the anterior chamber and, as far as possible, detach, near both corners of the section, the iris from the cornea. In all cases of "malignant" glaucoma, in which, after the operation, the anterior chamber is not restored, and the glaucomatous process remains unchecked, he presupposes a dislocation of the lens into the groove between the basis of the ciliary body and the origin of the iris. In such cases he recommends the "reduction" of the lens, ten to twenty days after the iridectomy, by paracentesis of the vitreous, and pres-

sure with the upper eyelid upon the cornea, for one to one and a half minutes. By this means and the above manœuvre with the spatula, he "hopes to eliminate the whole group of malignant glaucoma from the history of this disease."

In conclusion, he warns from too great expectations as to the curative effect of calabar bean, since this remedy, at the beginning of its action, increases the tension in the vitreous. He remarks that under its use he saw parts of the visual field being lost; but he warmly recommends pilocarpin (alkaloid of jaborandi) which he hopes will, in many chronic cases, either replace iridectomy, or improve its insufficient results.

11. M. believes that in cases of acute blindness, in which the ophthalmoscope reveals a condition of the fundus similar to that portrayed by Graefe and Schweigger as typical of embolism of the central artery, the diagnosis of embolism is often incorrect. He maintains that an apoplexy of the optic nerve is most frequently the factor, and bases his view on the observation of cases similar to the following:

Patient, a physician, æt. 66, previously healthy, had an attack of apoplexy in 1876, from which he recovered with a slight paresis of the right side, especially its upper extremity. On the 26th of September, 1877, after prolonged work with the microscope, his left eye became suddenly blind. He consulted M. on October 4th.

The fundus shows the change usually ascribed to embolism of the central artery, viz.: Region of disk grayish-white and cloudy; macula lutea appears as a bright-red spot, surrounded by a cloudy zone; arteries narrowed, though not very markedly so; veins immediately around and on the disk extremely attenuated, but not changed on the periphery; peripheral portions of retina normal.

There was complete amaurosis of the left eye, quantitative perception of light being entirely lost. An unfavorable prognosis was made. Three weeks later, the patient's sight had improved. On the 9th of October, fourteen days after the attack, he noticed a slight but gradually increasing sensibility to light in the inner half of the retina. Two weeks later, he counted fingers and distinguished surrounding objects with the same portion of the retina, while the outer half and the macula were insensible to even the most intense light. The pupil of the affected eye was of medium size, direct reaction extremely sluggish, consensual reaction prompt and very active. Examination of the fundus showed a uniform contraction of the arteries, which were very thin.

The retinal veins were of normal calibre near the periphery, becoming narrow in the immediate vicinity of the disk, and most strikingly so on the disk, which seemed to be smaller in size, and much paler than usual, especially in the outer half towards the macula, the nasal half being of a yellowish-red hue. The inner half of the retina showed no pathological changes, but around the macula there still remained a slight grayish cloud, in which the characteristic red spot could be distinguished. Near the external margin of the disk, reaching but not passing it, were two striped hemorrhages of a red color, of the length of one-half the diameter of the disk.

Two weeks later, the patient's condition presented no essential subjective changes. The ophthalmoscope showed the same appearances, excepting that the disk appeared smaller, though not entirely atrophic, having already regained a yellowish-red coloration. The grayish cloud around the macula and the red spot had disappeared; absorption of the retinal hemorrhages at the inner margin of the disk had already commenced, but close to and just below the disk there was a recent dark-brown hemorrhage. The inner half of the retina had remained sensitive, the outer half was still absolutely amaurotic. There is a marked disposition to retinal hemorrhages, which recurred quite often, as late as three months after the first attack.

M. excludes embolism on the grounds that the return of sensitiveness of the inner half of the retina would demand an increased collateral circulation, perhaps through the circumpapillary plexus of vessels—a condition not found on ophthalmoscopic examination. The arteries were equally atrophic and empty in all parts, hence the amaurosis could not have been due to an alteration of the arterial system causing anæmia, but must be attributed to a sudden paralysis of nervous transmission.

Hemorrhage from the central artery, lacerating and compressing the optic nerve fibres, had produced the paralysis. Subsequently absorption had commenced, or the blood had gravitated into the nerve-sheath, and some of the fibres having been restored to their normal condition, a part of the retina resumed its function. A unilateral recovery following acute amaurosis, if due to embolic processes, would be remarkable, but is easily explained by assuming a hemorrhage in the optic nerve. This case, moreover, proves that acute amaurosis in consequence of apoplexy of the optic nerve admits of a more favorable prognosis than is usually supposed.

12. In his monograph "On the Disturbances of Mobility of the Eye," Alfred Graefe formulated rules for the operative treatment of diplopia with vertical deviation arising from paralysis of the superior and inferior oblique muscles. In order to demonstrate the practical applicability of these rules, Kries publishes three cases operated upon at the clinic in Halle.

Case I. A woman, 46 years of age, suffered from annoying diplopia, caused by typical paralysis of the right superior oblique. At the median line, at a distance of 15″ from the eye, and 20° below the horizontal plane, the vertical deviation was corrected by a prism of 8° and fusion brought about by a prism of 14°. At first tenotomy of the *left* rectus inferior was done. The operation caused an excessive correction and the next day the left eye stood higher than the right. For the correction of the vertical deviation a prism of 5° was required in the above mentioned position (median line, 20° below the horizontal) and a prism of 8° in extreme left rotation. After the application of a conjunctival suture, the right eye stood 2° too high in the first, and 7° too low in the second position. The vertical deviation disappeared when the convergence was corrected. Tenotomy of the right rectus internus was performed, but had too great an effect, and necessitated the use of a limiting suture which again caused the result to be insufficient. Finally the left rectus internus was tenotomized, whereupon the diplopia disappeared.

Case II. A woman, 40 years of age, showed diplopia typical of paralysis of the left superior oblique. She had been in this state three months. Tenotomy of the right inferior rectus with limiting suture, and left rectus internus without limitation, was done at one sitting. Two days after the operation the diplopia had disappeared.

Case III. Man, 66 years of age. Paralysis of right superior oblique. Had been treated locally with constant and induced currents and generally with iodide of potassium. In the median line, at a distance of about 15″ from the eye and 35° below the horizontal plane, the vertical displacement was corrected by a prism of 9°, the convergence by a prism of 7°.

Tenotomy of left inferior rectus was done and limiting suture applied. Three weeks later no spontaneous diplopia existed. The eyes moved so harmoniously that even under the covering hand no deviation could be detected. When, however, the eyes were turned to

the extreme left and a colored glass was placed before one eye, the presence of homonymous diplopia was ascertained.

The result of the operation was perfectly satisfactory in all three cases.

13. Dr. J. L. Thompson makes, with a narrow-bladed knife, a straight section across the cornea ; puncture and counter-puncture are one-fifteenth of an inch external to the apparent corneal margin, and the centre of the section is one-ninth of an inch below its summit. The remainder of the operation is in accordance with Graefe's modified linear.

Both lenses were removed from the eyes of ten patients at the same time, all successfully. One of them was over 93 years of age, and "can see to read as well as ever."

There were only two failures ; all the others were able to read ordinary newspaper print when they returned home.

These results are excellent, and one fact is particularly worthy of notice, that, though the greater part of the section is situated in the cornea, suppuration of the cornea did not occur.

OTOLOGICAL PART.

A CASE OF CLEFT PALATE, WITH ACQUIRED DEAF-MUTEISM. STAPHYLORAPHY. RECOVERY.

By Dr. AD. ALT, M.C.P. and S.O., of Toronto,
Lecturer on Ophthalmology and Otology to the Trinity Medical School.

J. D., æt. 7 years, was brought to my office on the 21st of August, 1877. His mother gave me the following history of the case :

The boy, whose father had died from phthisis pulmonalis, was born with a cleft palate. His baby-talk was consequently different from that of other children, though he learned to speak at the right time. When two years and some months old, he had a severe attack of scarlatina, accompanied by some throat trouble. After his recovery from the fever, his mother noticed that both his ears discharged copiously, and his hearing was very much impaired. In spite of all sorts of treatment, by regular physicians and quacks, the discharge is said never to have been checked, and soon the boy heard only the loudest voice near his ear, and at the same time gave up talking altogether. Whenever he tried to say something, he uttered a number of inarticulated sounds, which not even his mother could understand. Lately he had been treated by an aurist with applications to the ear, and had since become perfectly deaf. What few words he understands, he reads from the lips after frequent repetitions.

Status præsens.—The boy has a very unhealthy scrofulous habitus. Has had only two upper front teeth, which are badly developed and stand crooked. The lymphatic glands of the neck and arms are greatly swollen and hard. The uvula and entire soft palate are cleft ; the two portions are comparatively well developed. The tonsils and the posterior wall of the pharynx are covered with a thick, sticky, purulent mucous ; a similar discharge is seen in the anterior nares. The secretion is very offensive. Both external auditory canals are filled with thick, likewise very offensive pus. After cleansing the ears, nose, and pharynx, I found the following conditions : Left membrana tympani

perfectly wanting ; right membrana tympani destroyed to a very great extent ; mucous membrane of both tympanic cavities dark-red and greatly swollen ; rhinoscopic examination, which, owing to the cleft palate, was very easy, showed that the mucous membrane of the pharynx and the tonsilla pharyngis were greatly swollen and hyperæmic. The same was the condition of the mucous membrane of the nose, especially around the orifice of the Eustachian tubes and the edges of the two lower conchæ.

My watch, which I hear at a distance of 20′, he hears R. at about 2 inches ; L. only when pressed against the ear. While he understands some of his mother's talk, by watching her lips attentively, I cannot make him understand my speech at all, and I have to communicate with him largely by signs ; nor could I form an idea of what he tried to say. Not even "yes" or "no" was distinctly understood. Yet his mother assures me again and again that the boy could speak comparatively well before he got so deaf (some three years ago). The sound of a tuning fork moved before his ears was well perceived. He could, however, evidently not hear a full military band which was just passing down the street while I examined him.

History and status præsens left no doubt that this was a case of acquired deaf-muteism.

The mother begged me to try anything to cure her boy, and though I had very little hope to restore his hearing, I thought at least I might, by local treatment, be able to improve it so far as to induce the boy to try to speak again. If I could accomplish that, I had no doubt that subsequently staphyloraphy would, on the one hand, guard to a certain extent against a relapse of the purulent disease of pharynx, nose, and ears, and it might, on the other hand, perhaps improve his speech.

I first treated the pharynx and nose by inflations of a powder containing five per cent of nitrate of silver. To the mucous membrane of both tympanic capities, I applied a sixty-grain solution of the same remedy, treating the boy every other day myself. At home, I advised his mother to apply Priesnitz' wrappings, to wash the boy with cold water all over his body every morning, and to rub him well afterwards. His ears were to be syringed as often as some matter could be noticed in them, and afterwards a few drops of a one-per-cent solution of sulpho-carbolate of zinc applied to them. To improve his constitution, I ordered, first, iron with rheum, later, cod-liver oil in large quantities.

Under this treatment the boy improved much quicker than I had

dared to hope. On the 25th of September (five weeks after I saw him first), the conditions of pharynx, nose, and ears, as well as his hearing (and even speech), were so far improved that I considered it opportune to perform staphyloraphy. There was at the time only very little discharge from the ears, none from the nose and pharynx. The swelling of the mucous membranes was greatly reduced ; h. R. = $\frac{9}{200}$; L. = $\frac{10}{100}$. Loud voice at about 3′, yet he understands only some words ; others he does not seem to comprehend, because he has never heard them before, or because, if he knew them once, he has forgotten their meaning. His speech, though extremely indistinct, begins to sound more articulate, and there are some words (like "no," "man," "nine") which he can pronounce very well.

When consulting my library with regard to similar cases and the opinion of the authors as to an operation at so early an age, I was astonished to find nearly all of them agreeing upon the necessity of waiting until the patient is at least fifteen years of age.*

I did, however, not hesitate to perform the operation in my case. The boy stood all manipulations in the pharynx so well that I did not doubt he would stand the operation also. If he should, however, have behaved so badly as to render the operation impossible without the administration of an anæsthetic, I was decided to give one. I would then have made use of the newly adopted method for similar operations, in which the patient lies on his back and the head is hanging down over the edge of the bed or table. The reasons why I wanted to do the operation at any rate just at that time are obvious. I stated above that I expected to improve the patient's speech and guard him against a relapse, which might be caused any day by the inhaling of obnoxious substances by the mouth.

I performed the operation on the 25th of September, with the kind assistance of Dr. Senkler, of this city, without an anæsthetic. After the

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* *Dieffenbach* (Operative Chirurgie, Leipzig, 1845, p. 440) says : "The operation is to be performed on adults only." *Agatz* (Handbuch der chirurg. Operationslehre, Würzburg, 1856) says : "The operation is done on adults only." Several others state the same.

application of the sutures, the lateral parts yielded so readily to the traction that I did not consider it necessary to make lateral incisions. I put three sutures into the palate, and one into the shortened uvula.

There was very little reaction after the operation. The boy was fed in the common way by fluid substances, and felt so well that his mother could hardly keep him in bed and from trying to talk. Three days after the operation, the suture in the uvula cut through, but the upper parts were so well united that I removed one suture on the fifth, and the remaining ones on the sixth day. That day the mother left the boy for some time unwatched, and when I came in the evening to see him, she told me he had availed himself of her absence by calling his brother, who was down in the yard This effort had broken the union of the parts nearest to the hard palate. There remained, however, a broad bridge between the new hole and the uvula. The hole was closed up afterwards by the use of nitrate of silver in substance, and then of nitric acid.

The result of this operation was that the boy began to speak a little more distinctly, and by the constant exercise went on gaining daily. A week after the operation there was an attack of acute periostitis of the left mastoid process. It passed off after the application of some leeches. As soon as possible I resumed the local treatment of the pharyngeal and nasal mucous membranes. His hearing was all the time gradually improving.

On the 23d of October, I performed a smaller operation to close the uvula. The wound healed readily, and without any trouble.

On the 5th of November, the ears ceased to discharge, and on the 16th of the same month his hearing was so much improved, that he had h. R. and L. $\frac{125}{200}$. Loud voice was now heard distinctly at fifteen feet.

All the time the boy learned new words, and to pronounce old ones he had formerly not been able to pronounce. It was very difficult, if he wanted to say something quickly, to keep him from falling back into his old manner of uttering perfectly inarticulated sounds. The bad condition of his front teeth was a considerable obstacle to improvement. It prevented the distinct pronunciation of *d*, *t*, *l*, *f* and *s*.

On the 15th of December I discharged him, being convinced that by medical treatment he would not be improved any further.

The conditions were then as follows :

No discharge from either ear ; mucous membrane of the tympanic cavities no more swollen and hyperæmic. Mucous membrane of nose and

pharnyx normal, no morbid secretion. Eustachian tubes easily permeable; h. L. $\frac{150}{200}$; R. $\frac{200}{200}$. Loud voice at twenty feet with either ear.

I advised the mother to take the boy to some institute for the deaf and dumb, to have him taught the right pronunciation of every letter. She felt, however, confident that she could teach him how to speak more intelligibly.

I since saw the boy once more on the 25th of January, 1878. There was no discharge from the ears. The mucous membrane of the tympanic cavities was rather grayish-white (sclerosis), h. the same as on the previous examination. Medium loud voice, L. at 25, R. at 20 feet. The palate is well moved, but a little shortened by the retraction of the scar. Nose and pharynx are in normal conditions. The boy hears and speaks now well enough to go to school and do all the errands for his mother. When talking, he does not open his mouth well, unless he is told to, and thus his speech is not always as good as it might be. *S*, *d*, and *t* are very imperfectly pronounced, on account of his front teeth. The mother, who is extremely thankful, tells me that he annoys her constantly by asking explanations of the most common words, and evinces great interest in everything that is going on, whilst formerly he was a silent, sulky boy. He hears everything that is spoken, and can tell when the soldiers are coming, even if their band is still far off.

The boy has now quite a healthy look and round cheeks. The swelling of the lymphatic glands is greatly diminished, yet has not altogether disappeared. I am confident that, if the boy's second front teeth will grow in better shape and position, he will be able to speak as if nothing had been the matter with his palate. If the teeth should become as badly developed as the present ones, I advised his mother to have them replaced by artificial ones.

I do not know whether any similar observations have been reported. I think, however, there is, besides the personal pleasure it afforded me, enough of general interest in this case to justify its publication.

ON THE BLOOD-VESSELS AND THE CIRCULATION IN THE MEMBRANA TYMPANI AND MANUBRIUM MALLEI: A SERIES OF INVESTIGATIONS

By Prof. S. MOOS, Heidelberg.

(With Plates VI. and VII.)

(From the Heidelberg Institute for Pathological Anatomy.)

Translated by James A. Spalding, M.D., Portland, Maine.

I was led to make these present researches by the accidental discovery of blood-vessels in the substantia propria, close to the manubrium of both membranæ tympani of a child, which, in 1868, I had already subjected to a closer examination, in order to learn more clearly the anatomical relations between the manubrium mallei and the membrana tympani; the result of which I published in 1869.*

Various reasons led me at that time to regard those vessels in the substantia propria as *pathological.*

The membrana tympani in question belonged to a child born in the Lying-in Hospital in this town, in a state of asphyxia, brought to life by artificial respiration, but dying ten days later from general atrophy.

My reasons for regarding these vessels as *pathological* were as follows:

1st. All the authors (Wharton Jones, Arnold, Toynbee, Gerlach, Henle, Politzer, etc.) who, up to this time, had mentioned the circumstance, were unanimous in declaring the substantia propria to be *devoid of vessels.*

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* Researches into the Relation between the Manubrium Mallei and Memb. Tymp. These Archives, I., 283.

2d. Prussak especially, in his book* just then published, in which the anatomical and physiological relations of the circulation of blood in the membrana tympani and tympanum had been subjected to renewed research under Carl Ludwig's guidance, declares explicitly, and anew, *that the substantia propria of the membrana tympani has no vessels.* "I will just mention here," says Prussak (l. c., 108), "that all the blood-vessels of the membrana tympani are found, on the one side, in the continuation of the cutis only; and, on the other side, in the continuation of the mucous membrane of the tympanum only."

In reflecting upon these reasons cited, I was then so much convinced of the *pathological* character of the blood-vessels discovered in the substantia propria of these membranæ tympani that I was led to try, experimentally, whether we might not, by producing vascular inflammation on the membrana tympani of animals, throw farther light upon the matter in question. Pigeons were chosen for experiment, and as an experimental method, the one used to produce vascular inflammation of the cornea. But my experiments had a negative result only. They all led to a mere hyperplasia and pigmentation of the structural elements of the membrana tympani; a real vascular inflammation was never gained.

Meanwhile, papers on the same subject, by Kessel, appeared in the Medical Central-Blatt † and in Stricker's "Treatise on Tissues."‡ His results, gained partly by the silvering and gilding methods, partly by the injection of specimens, led to the general conclusion that the membrana propria of the membrana tympani carries nerves, blood-vessels, and lymphatics. One notices between the separate fibres of the membrana propria narrow fissures, such as are seen in connective tissue, and larger spaces filled in with granules, clinging to the walls, and amœ-

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* Dr. A. Prussak, "On the Physiology and Anatomy of the Circulation of Blood in the Tympanum." Reports of the Royal Saxony Society of Sciences. Session May 9th, 1868. Presented by C. Ludwig.

† On the Nerves and Lymphatics of the Memb. Tymp. 1869, Nos. 23, 24.

‡ The External and Middle Ear. Vol. II. 338 et seq.

boid cells. These larger spaces are to be considered as vessels, piercing through transversely or obliquely.

A fine, fibrous superstructure, situated between the mucous membrane and the membrana propria, and bridging over the latter, forms tunnel-like openings into which the nerves, blood-vessels and lymphatics enter, so as to reach the side turned towards the external auditory meatus, after passing through the radiating fibres. As to the capillary network situated midway in the membrana propria, it spreads out between the radiating and circular fibrous layers, as well as in the system of cavities, clinging closely to its walls. At the middle and inner portions, situated between the manubrium and tendinous ring, the capillaries pass more transversely or obliquely from the outer capillary network, situated between the radiating fibres, to the inner capillary network of the mucous membrane, so that this district of the membrana propria appears most devoid of vessels. The radiating fibres split asunder here and there towards the periphery, leaving channels between one another, which are filled up with capillaries of a quickly increasing diameter. Hence the vessels themselves run radiatingly, and with regular interspaces. Kessel does not go into further details as to the anatomical character of the blood-vessels which pierce the membrana tympani.

Nothing more has appeared on this point since the publications of Kessel. Henle* says, lately, "The fibrous layer of the membrana tympani has neither vessels nor nerves. The vessels and nerves in which the membrana tympani is rich belong to the envelopes which it gains from the cutis and mucous membrane." . . . . However, Kessel's contradicting observations are cited in a note.†

OBJECTS USED AND METHODS OF INVESTIGATION.

(*a.*) *Membranæ tympani of animals :* rabbits, dogs, sheep, calves, goats; injected and uninjected; treated with gold chloride and hyperosmic acid.

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* Eingeweidelehre. Zweite Auftage, dritte Lieferung, page 667.

† Ibid.

(*b.*) *Membranæ tympani of man :* fœtus, new-born children children from one day to six months of age, adults. A larger number of preparations taken from the fœtus and from dead infants were such as had been used for other purposes in Dr. Küttner's pathological laboratory after injections with Prussian blue into the abdominal artery. Others were injected from the common carotid, some with Prussian blue, others with carmine glue. I obtained from Professor Thoma some very beautiful preparations from animals where the injection had been made for other purposes, into the common carotid with Prussian blue, in the following way :

The jugular veins being opened, and at the same time both common carotids and jugular veins tied centripetally, injection was made simultaneously into each common carotid.

On comparing the various preparations more closely, there was found, on the one hand, in specimens injected from the abdominal artery, a not unfrequent imperfect filling of the vessels concerned (as was to have been expected); but, on the other hand, there was an almost constant freedom from extravasations that so often disturb investigations.*

An injection from the abdominal artery is quite sufficient for studying the relations of the larger vessels, but not extensive enough for those of the capillaries; for these purposes, Thoma's method offers the best preparations.

The treatment with hyperosmic acid is also very worthy of recommendation. If we submit the membrana tympani of an animal, or one taken from a recent cadaver, to the action of a one-per-cent solution of this acid for forty-eight hours, the contents of the vessels are coagulated so stiffly that our judgment as to the anatomical character of the wall of the vessel is rendered much more easy.

Plane-preparations, and sections made transversely and longi-

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* When the vessels are filled imperfectly, we gain the advantage of an easier judgment as to their anatomy. Do not be deceived by the slighter tinting of the injected objects so often noticed. Many of these show perfect success in the injection, if we let them stay in turpentine for twenty-four hours before sealing them in Canada balsam.

tudinally through the membrana tympani, malleus, annulus, etc., were used in these investigations.

Wherever the end demanded it, some of the plane preparations of the whole membrana tympani in union with the manubrium and the annulus, were sealed in a hollowed slide with Canada balsam, and used for investigation. Some of the drawings appended are taken from preparations made in this way.

Lastly, as good objects for examination, we may use naturally-injected specimens from new-born children, after they have been treated for some time with Müller's solution, then with absolute alcohol, and which can with advantage, or at pleasure, be tinted with carmine or hæmatoxyline.

In studying the perforating branches, transverse and longitudinal sections of the membrana tympani were used by preference.

In the course of my researches as to the relations of the circulation of blood in the membrana tympani, I had become convinced that the study of the distribution of the blood, and of its course upon the membrana tympani, must remain defective so long as we possess no view as to these same relations of the manubrium mallei, bound so intimately and peculiarly as it is with the membrana tympani. In order, now, to examine successfully the relations of the blood-vessels on the inner surface of the integument of the malleus, we must split this longitudinally with fine scissors, loosen it, turn the loosened parts upon themselves, and (depending upon our special purpose) even go so far as to remove afterwards the manubrium from its attachments.

If the results of my researches on this subject, hitherto left unstudied, give but partial information as to the relations of the blood-vessels between the membrana tympani and the manubrium mallei, the fault is due to the great technical diffities offered to the examination of so minute an object.

The nature of the subject makes repetitions unavoidable in describing the results of researches into a theme now taken up anew, and one to which so many distinguished observers have

already devoted their time. Hence all that I have found new in such a province as this can only connect itself intelligibly with facts already known, and now correctly recognized. Therefore the reader will not be surprised if, in the following statements, the results of my researches agree in many respects with those of other authors.

BLOOD-VESSELS OF SHRAPNELL'S MEMBRANE.

By Shrapnell's membrane we understand, of course, that portion of the membrana tympani situated above the short process (compare fig. 7), at a lower level than the plane of the rest of the membrana tympani, and bounded above by *Rivini's* segment, and laterally by two folds running from the ends of the latter to the short process. This portion of the membrana tympani has no substantia propria. It is *perforated*, especially at its posterior portion, by arterial and venous vessels, which form an important union between the blood-vessels of the superior and posterior wall of the external auditory meatus and those of the tympanum. The discharge of the blood from the tympanum is, as we shall see later, undertaken chiefly by the veins perforating the posterior portion of Shrapnell's membrane. The supporters of the blood-vessels *within* this membrane are the fissures in the fine connective-tissue fibres provided by the inner stratum of the cutis layer (compare fig 7).

The delicate arterial twigs perforating the membrane, originating from the main current of the arteria auricularis profunda, separate quickly within the membrane into capillaries which form a thick network on the neck of the malleus and neighboring parts of the processus folianus. Moreover, according to Rüdinger (Atlas des Gehörorgans), the main stem of the artery of the manubrium mallei, before crossing over to the manubrium, sends off branches at the anterior and posterior periphery into the sulcus tympanicus. These, in coursing downwards, dissolve in the fibrous tissue* between the annulus

* Compare fig. 5 ; at *p* we find hints of these capillaries, although the sketch was made from an uninjected specimen.

osseus and tendineus into a network of capillaries surrounding the whole annulus. I am able to confirm Rüdinger's statement, that this network of capillaries anastomoses with the arterial vessels of the external auditory meatus, and with those running radiatingly in the cuticular layer of the membrana tympani, and, moreover, from discoveries in transverse sections of injected specimens from children, I can go farther and say that these unite, moreover, with the periosteal capillaries of the annulus, and those on the rim of the mucous membrane of the tympanum.

The venous vessels perforating Shrapnell's membrane take their origin from the circle of veins in the tympanum, as also from the veins ascending upon the mucous surface of the manubrium and laterally from the same. These perforating veins conduct a large part of the blood from the tympanum and from the veins of the periosteum of that part of the manubrium turned towards the mucous membrane, to the veins of the superior and posterior wall of the external auditory meatus.

In a *clinical* point of view, we may notice especially as regards this region:

If we examine well-injected plane-preparations, in a hollowed slide, we *are struck by the frequent failure of the injection over the short process.* Now, as a point of fact, we find frequently, in hyperæmia and inflammations of the membrana tympani, that the short process is not injected; "not unlike an acne-pustule, surrounded by a red contour" (Politzer, Beleuchtungsbilder, page 37). This proves that the cutis over the short process has but very few vessels.

OUTER NETWORK OF VESSELS OF THE MEMBRANA TYMPANI.

The supporter of the outer network of vessels is a thin stratum of connective tissue (lying between the deep cells of the rete Malpighi and the radiating fibrous layer) which, at the periphery of the membrana tympani, is simply a continuation of the corresponding layer of the cutis of the external auditory meatus; moreover a thick strip of cutis extends from the

superior wall of the external auditory meatus to the membrana tympani. This runs about ½ to 1 mm. behind the manubrium, and touches it at its lower end at an acute angle; it is made up of connective tissue and elastic fibres: Prussak's "descending fibres of the membrana tympani." This strip of cutis is the bearer alike of blood-vessels and nerves, which cross over from the external auditory meatus upon the membrana tympani. These fibres spread out radiatingly at the end of the manubrium, and at this point are united intimately with the radiating fibrous layer of the membrana tympani.

The source of the *external arterial* network of vessels is the arteria auricularis profunda, which sends out between two veins a small twig, which courses from the posterior superior wall of the external auditory meatus, at first *behind** the manubrium, and then farther downward, *upon* the same, after touching it at the beginning of its lowest third at an acute angle.

Two smaller twigs pass off from the beginning of the main stem, in a radiating direction, to both sides. Just at the beginning of the last third of the manubrium (fig. 12), the main stem branches like a fork into two larger branches which, after encircling the end of the manubrium like an arch, unite again with one another. Moreover, branches pass off from this arch in a centrifugal direction, and supply the inferior middle, and both inferior lateral segments of the membrana tympani with arterial blood.

Sometimes the main stem, before dividing into a fork, keeps on to the end of the manubrium, which it touches, as before, at an acute angle. In such a case, the arch made by its forked branches lies somewhat lower down towards the inferior periphery of the manubrium.

We find in the fissure which remains vacant between the fork and the arch sometimes one, sometimes numerous anastomoses, of very thin calibre, which in greater or less curves pass from one side of the fork to the other, across the manu-

*Compare figs. 3, 4, 6, 7. I saw a successful wax injection of this twig in Politzer's collection in Vienna.

brium, so that we get the impression of a manifold formation of arches lying upon the inferior third of the manubrium. A few minute twigs pass off, upward and downward from these arches (which I will call *secondary*), and are lost in the capillary network.

Sometimes, besides this main arterial stem, one or two other small arterial twigs pass from the external auditory meatus to the manubrium. These lie always behind the main artery of the manubrium.

In one preparation, I failed to find the bow-shaped arrangement of the forked branches of the main artery.

Those branches which pass off from the main artery of the manubrium, in the centrifugally radiating direction of the membrana tympani, break up, in a zone situated not quite intermediate between the region of the manubrium and the periphery of the membrana tympani (say the outer third), into a fine network which is connected intimately with an arterial capillary network made up of minute arterial twigs. The branches, coming from the external auditory meatus, coursing along the periphery of the membrana tympani, and crossing over upon it, give off, after a short centripetal course, some thinner anastomosing branches for the network formed by the centrifugal radiating branches. We find farther, in the interspaces alike of the centrifugal and centripetal vessels, arched anastomoses, from whose relations we get the impression of a *structure of capillary loops*, but which in its arrangement differs essentially from that which we find upon the mucous surface of the membrana tympani of various animals, in which, as we shall see later, the impression of a looped formation is produced by a literal turning of the vessel upon itself. According to Prussak, the branches on the manubrium give off still shorter branches, which anastomose with those nearest them, while a second sort cross over, by short, reticulated loops, into a plexus of veins which wreathes around the circumference of the manubrium.

The external arterial vessels of the membrana tympani, running radiatingly and centrifugally, make a third anastomosis with the network of vessels in the sulcus tympanicus. Com-

pare above, in the description of the vessels of Shrapnell's membrane.)

Finally, as we shall see later, a few twigs pass off as well from the main stem of the artery of the manubrium itself, as from its side branches, close to its origin, to the periosteum of the lateral parts of the manubrium and its edges, and anastomose with the arterial network of the mucous membrane.

VENOUS VESSELS OF THE CUTIS LAYER.

According to Prussak, the loops of the arterial branches, running radiatingly and centrifugally, and arranged in loops as just described, pass over into the plexus of veins just mentioned as surrounding the circumference of the manubrium. The arterial branches, running radiatingly in straight lines over the membrana tympani quite to its edge, send branches partly into the two veins accompanying each arterial twig in its course over the membrana tympani, but partly open into the cuticular circle of veins at the outer edge of the membrana tympani. This circle of veins is united also with the plexus of veins on the mucous surface of the membrana tympani at the annulus (compare figs. 5 and 6): furthermore, as emptying into the network of veins situated between the manubrium and the periphery of the membrana tympani, we may mention those veins perforating hither from the mucous membrane in an oblique direction (comp. fig. 1); and finally, as we shall see later, the veins passing out from the periosteum of the manubrium through the substantia propria, empty their blood into the cuticular network of veins lying opposite the manubrium (compare figs. 1, 4, 7). The two larger veins, united to one another at the manubrium, and having the artery between them, as also the plexus of veins of the manubrium, empty their blood into the veins of the external auditory meatus; the former after having first received the veins coming from the sulcus tympanicus. The cuticular plexus of veins on the edge of the membrana tympani empties its blood either into the external auditory meatus, or (when resistance is present) into

the network of veins in the mucous membrane of the tympanum; the veins situated between the manubrium and the edge of the membrana tympani empty their blood either into the veins of the manubrium, or, as I have discovered, confirming previous statements, into the veins which are united with those of the mucous membrane, perforating the membrana tympani in an oblique direction (fig. 1). Finally, the veins of the cutis, situated opposite the manubrium, might (as will be shown by my further deductions as to the connection of the veins of the periosteum of the manubrium with the network of veins of the cutis), in case of great resistance for their centripetal flow, empty their blood, at times, into the veins of the substantia propria lying opposite the manubrium.

It is plain from the previous description that the cuticular arterial blood can pass over into the veins in very varying ways. "The paths which the blood may follow during life will depend evidently upon the nature of the resistances which are met with in the various sets of pathways, especially in the veins. But we can say with certainty that the arterial blood returns always along the shortest path through the plexus at the manubrium, in case no especial resistance is met with in the veins into which the vessels composing that plexus empty." (Prussak, l. c., page 113.)

BLOOD-VESSELS OF THE SUBSTANTIA PROPRIA OF THE MEMBRANA TYMPANI.

According to Kessel's description, cited in the introduction, the vessels of the membrana propria show a double relation. Some have a decidedly *perforating* character, *i. e.*, they pass from the mucous surface through the membrana propria to the cutis, or inversely in an oblique or transverse direction. These are therefore decidedly *passers*. Others spread themselves out between the radiating and circular fibrous layers, as also in the cavernous system of the membrana tympani, clinging closely everywhere to its walls. It is not easy to make a thorough criticism, fact for fact, of Kessler's work, in so far as this point is

concerned, for, at one place, he speaks of lymphatics and blood-vessels only; therefore, we do not know whether he means by this arterial or venous vessels, and besides this, his work lacks explanatory figures.

As to the perforating blood-vessels of the membrana tympani, or the *passers*, as I will call them, my investigations show that between the veins of the mucous membrane and those of the cutis within the zone intermediate between the manubrium and the periphery of the membrana tympani, there exist numerous anastomoses, which perforate the membrana partly in a transverse, partly in an oblique direction. But I could not prove with certainty any arterial anastomoses. I was able to confirm the union between the external and internal network of veins in injected and uninjected transverse and longitudinal sections (fig. 1) of the membrana tympani of children. On the other hand, I could gain no decisive result as to a possible union between the internal and external network of arterial vessels, in any of the well-injected plane-preparations from rabbits and dogs, when examined upon a hollowed slide.

Nor could I confirm the existence of the network of capillaries described by Kessel, between the layers of radiating and circular fibres. In this examination I made use of:

1st. Longitudinal and transverse sections of the membrana tympani of children and adults, treated with osmic acid.

2d. Transverse sections of injected membranæ tympani of children, made through the manubrium, the membrana tympani, and both annuli.

3d. Injected plane-preparations of membranæ tympani of rabbits, in which each single layer of the membrana tympani was separated from the other.

4th. Plane-preparations from a young goat, treated with gold chloride.

Although I was unable, by means of all these methods, to confirm these unions and the capillary network in question, between the circular and radiating fibrous layers, yet I am very far from denying their existence.

The positive results of my investigations will be found in the following pages. (Compare figs. 1, 2, 3, 4, 6, 7, and 8.)

With exception of the region opposite the manubrium, we do not find in any of these preparations any vessel, or even any fissure for a vessel, between or in the two layers of the substantia propria, while, in the whole zone between the manubrium and the annulus, as well in the submucous as in the cutis layers, these fissures and even the perforating vessels of the zone in question are to be seen distinctly. On the other hand, in the *substantia propria in the region of the manubrium*, we do find the fissures made by cutting across the ends of blood-vessels running transversely and longitudinally.

As to Kessel's capillary network, between the radiating and circular layers, I would draw especial attention to figs. 4 and 5. In fig. 4, made from an injected specimen, the distinctness of the capillaries of the *cutis* leaves nothing to be desired, while there is not the least hint of capillaries in the substantia propria; and, in case any one raises the not unplausible objection, that the capillaries of the substantia propria, perhaps, never fill* even in the most successful injections, then I would ask in reply, Why do we see in fig. 5, which shows the relations of the blood-vessels of the annulus, *from an uninjected specimen*, the fissures of the capillary network in the annulus, *while in nearly every other preparation I have failed to find fissures for the capillary vessels in the substantia propria?*

I must therefore gather together the results of my investigations in so far as concerns the presence of blood-vessels † in the substantia propria.

The zones of the substantia propria of the membrana tympani, situated intermediately between the manubrium and the periphery of the membrana tympani, possess surely numerous perforating vessels, which are of a venous nature, and which, in so far as concerns the blood circulation of the membrana tympani, form a not unimportant

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* Also, "the membrana tympani, as many trials have proved to me, is one of those parts which very seldom inject perfectly, even with the most delicate masses." Gerlach (l. c.), page 62. Prussak coincides with this view, l. c., 102–103.

† My work had nothing to do with lymphatics.

union between the veins of the cutis and those of mucous membrane.

The relation of the blood-vessels of the membrana propria in the region of the manubrium itself shall be described more accurately farther along.

THE BLOOD-VESSELS OF THE PERIOSTEUM, OF THE MANUBRIUM MALLEI, AND OF THE MEMBRANA PROPRIA IN THE REGION OF THE MANUBRIUM MALLEI.

The supporters of the blood-vessels of the envelope of the malleus are its periosteum, and the membrana propria bound to it more or less intimately, according to the age. In transverse sections through the manubrium of embryos, we can distinguish very easily the borders between the real periosteum or perichondrium, and the membrana propria; this becomes ever more difficult with increasing growth, and I possess not a few transverse sections of the manubrium of children and adults in which it is impossible to determine the border line, and where we must declare the membrana propria as the real periosteum of the manubrium.* The border-lines can be determined often by variations in the tint, in tinted preparations; that is to say, the innermost layers of the membrana propria are often less intensely tinted than the real periosteum.

As to the separate layers of the membrana propria, both the radiating and the circular are united, as is well known, with the periosteum of the manubrium. The circular layer is absent at the inferior third of the manubrium; here, the periosteum of the manubrium is united intimately with the radiating layer only, and much more so than at the superior parts of the manubrium, where the circular layer undertakes this *rolc*. But while at the inferior third of the manubrium the radiating fibres insert themselves from all sides upon the manubrium, and really surround it, at the superior parts the fibres of the circular layers pass either to the anterior or posterior angle of

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* A drawing with reference to this point can be found in my work in these ARCHIVES Vol. I., Part I., Plate 8, Fig. 2.

the manubrium only, or they embrace the whole manubrium in the form of a narrow loop, united with it more or less intimately.

Now then, in order that the blood at the lateral surface of the manubrium, that is to say, at the surface turned towards the external auditory meatus, can flow to and fro, it is natural, by necessity, that the collective layers of tissue placed in front of the manubrium should be perforated by the blood-vessels in question, and as the inferior third of the manubrium is united much more intimately with the radiating layer, and as the fibres of this layer are spread more thickly than farther upwards, it follows that a passage for the blood-vessels will be much more possible at the superior parts of the manubrium than at its inferior third. In fact, the results of investigations of injected and uninjected transverse and longitudinal sections correspond with these theoretical suppositions. Perforating vessels of both arterial and venous nature are extremely rare in the membrana propria in the region of the inferior third of the manubrium, while in the district where the circular layer is united with the envelope of the manubrium such vessels are demonstrable much more often, and proportionately more easily.

PARTICIPATION OF THE ARTERIAL CURRENT OF THE CUTIS-LAYER AND OF THE MUCOUS SURFACE IN THE NOURISHMENT OF THE MANUBRIUM MALLEI.

If we look over a larger number of *uninjected* cross-sections from the middle or superior third of the membrana tympani and manubrium, we notice constantly that, whether the circular layer crosses over upon the manubrium in front or behind, or surrounds it in the form of a band, bound more or less intimately with it (crossing of its fibres in front of the manubrium), there remain between the manubrium and the membrana propria, sometimes in front, sometimes behind, sometimes on both sides, both smaller and larger fissures which are filled up with the submucous layers.

In this space, filled in with the submucous tissue, we find, in

cross-sections of *uninjected* specimens, that we have cut across, in various directions, the mouths of one or more larger or smaller fissures for vessels, of which those running perpendicularly belong to the network of vessels of the mucous membrane.

If we examine *injected* transverse sections, we find as follows (fig. 4):

The vessels which are given off from the network of arterial vessels of the cutis to the periosteum of the manubrium arise either *directly* from the main artery of the manubrium, or near the main branch, from a twig thereof, which courses radiatingly to the anterior or posterior periphery of the membrana tympani. In both cases, these arteries perforate the layers of connective tissue* situated between the cutis and the manubrium, until they reach the space just described as filled in with the sub-mucous layer, that is to say, *within the tympanum.* On reaching here, the twig remains either isolated, in which case it surrounds the periosteum of the corresponding angle of the manubrium, or it forks, one branch wreathing around the periosteum of the anterior angle of the manubrium, the other around the periosteum of the posterior angle. I have noticed this latter relation more frequently at the superior third of the manubrium, the former more frequently at the middle third. I was unable to prove in any preparations the presence of arteries originating from the cuticular network, and coursing to the periosteum of the inferior third of the manubrium.

This anatomical fact offers exact proof that the arterial current of the cutis-layer of the membrana tympani takes a moderate share in the nourishment of the upper parts of the manubrium. We learn here, also, to recognize a new anastomosis between the network of arterial vessels of the cutis and those of the mucous membrane, for the perforating vessels in question

* In order to estimate correctly what we find in cross-sections, we must remember that the origin and end of these vessels do not always lie in the same plane in the cross-section ; hence we gain sometimes the picture of a vessel beginning, as it were, blind. This, also, is naturally the case when the origin and end of the vessel lie in the same plane of the section, but when the section itself it not made exactly horizontal. (Compare on this point fig. 2.)

spread out upon the periosteum in close meshes, which anastomose with the capillaries of the periosteum, springing from the arteries of the mucous membrane. But the nourishment of the manubrium by the arterial blood of the cutis-layer must be limited, as the manubrium at both its angles and medial surface, and also at the greatest part of its circumference, is covered with the mucous layer (rich in vessels), which offers preferable material for the nourishment of the manubrium. The fountain head of this network of vessels is, as we shall see later, the artery resting upon the manubrium, and which is made up of a tympanic branch of the temporal artery, coming in through the Glaserian fissure, and a tympanic branch arising from the stylo-mastoid artery.

As to the closer anatomical relations of the vessels of the manubrium, our study of injected membranæ tympani of rabbits showed that the twigs of the main artery run to the periosteum, partly in a transverse direction, partly downwards and upwards. If we use but slight magnifying powers, we see that these ascending and descending twigs of the main artery decrease but slightly in calibre after a short course, and then spreading apart, scatter themselves over the region of the manubrium. If we use higher magnifying powers, we see that the twigs of the main artery, just as they begin to cross to the manubrium, give off anastomoses stretching alongside of one another, and sending off but few minute twigs, and that, finally, the terminal branches of the main stem dissolve into an extremely delicate network, out of which the capillary network of veins is formed. I was able to confirm the existence of both a superficial and deep-seated capillary network of vessels in one specimen where the injection was unusually successful; the former was slightly closer in its meshes than the latter, and the calibre of its vessels was somewhat thinner than in the latter. I regard the deeper-seated network as made up of veins.

VENOUS VESSELS OF THE PERIOSTEUM OF THE MANUBRIUM.

From the capillary network of veins there originates a collection of larger twigs, some of which, at that spot where the

envelope of the manubrium is covered with mucous membrane, debouch into the larger venous stems of the mucous membrane coursing off over the manubrium, and some, at that spot where the ligaments of the pouch unite with the manubrium, debouch into the venous branches of the pouches of the membrana tympani.

The periosteal network of veins of the lateral envelope of the manubrium shows the following relations (compare figs. 7, 8, 9):

(*a.*) A few venous capillaries, at the inferior third of the manubrium, pass quite horizontally outward from the envelope of the manubrium, and open *directly* into the network of veins of the cutis.

(*b.*) A few pass off, rarely in a horizontal direction, mostly obliquely, until they reach between the circular and radiating layers, when they ascend perpendicularly between these layers and open into the larger veins opposite the manubrium, viz., the veins perforating the membrana propria, whose closer relation shall be described at once. Into these veins open also:

(*c.*) Venous capillaries which, at the inferior and middle third of the manubrium, run upward and somewhat tortuously; and,

(*d.*) Venous capillaries coming hither transversely from the manubrium; and finally,

(*e.*) Venous capillaries passing perpendicularly downward, after originating from the periosteum between the short process and the beginning of the manubrium.

These venous capillaries of the lateral periosteum of the manubrium, just described, pour their blood into larger venous spaces found between the periosteum of the manubrium (that portion thereof, namely, covered by the circular fibrous layer) and the radiating fibrous layer; that is to say, just about in the circumference of the upper two-thirds of the manubrium, and which take a double course (fig. 7 shows this clearly), first in a more horizontal direction to the network of veins in the cutis in which course they decrease in calibre, and secondly, in an oblique direction upwards, towards the short process, to the great veins of the manubrium, in which course they increase in cali-

bre. The veins of the first category have a more winding, those of the second, a more direct course. The veins of the second category find occasional anastomoses in an oblique direction to the network of veins of the cutis before their larger stems open directly into the main venous branches of the cutis-layer which pass to the external auditory meatus.

Fig. 11 shows that the veins just described anastomose even quite extensively with each other in their course.

We find something striking when we examine this relation, just described, with slight and especially with stronger magnifying powers. In the latter case especially, we gain the impression of structures of cavernous tissue.

In the fœtus, these veins perforating the substantia propria reach downwards quite to the end of the manubrium (compare fig. 1, showing the cross-section of the end of the manubrium from a child born dead at eight months), and the venous vessels are relatively larger. But the more the differentiation of the individual layers of the membrana tympani is progressed in, the more intimately, namely, do membrana propria and the periosteum at the inferior end of the manubrium melt into one another, so much the more do the perforating veins at the inferior third become obliterated, so that what we find in a child born at time may be even identical with that in an adult.

In the relation just described, we learn to recognize a *new* source of outlet of the blood from the middle ear to the external auditory meatus. The results of my investigations show, on the one hand, the way in which a larger part of the blood which has served to nourish the manubrium flows back from it, and, on the other hand, how the blood already poured out into the membrana propria lying opposite the manubrium flows back into the general venous circulation. *As the blood in the cutis and mucous membrane of the membrana tympani may ebb in various ways, so is this also the case with the venous blood of the substantia propria.*

I would lay especial stress upon this fact in a physiological point of view. For the physiological dignity of a membrane like the membrana tympani which, as physics teach and as clinical

experience confirms, is so easily disturbed in its normal arrangements by variations of pressure on both its surfaces, demands, above all, such an anatomical structure that even in its normal state no hindrances within itself shall be opposed to its reception and conduction of vibration, by any check to the circulation of its blood. But now, by the two sources of outlet of venous blood in the substantia propria, as just described, such disturbances in a normal state will be surely quickest compensated for, or even hindered.

INNER NETWORK OF VESSELS OF THE MEMBRANA TYMPANI.

The mucous surface of the membrana tympani draws the greatest part of its *arterial* blood from an artery running parallel with the inner surface of the manubrium, quite to its end, originating in a somewhat bow-shaped union of two tympanic branches near the neck of the malleus. One of these, and the larger branch, arises from the stylo-mastoid artery (from the posterior auricular artery) which, coming from the posterior wall of tympanum, courses in company with the chorda tympani to the posterior superior segment of the membrana tympani and nourishes the posterior pouch with its blood; the other, the slighter branch, originates from a tympanic branch of the temporal artery, entering through the Glaserian fissure, and coursing to the anterior segment of the membrana tympani; this nourishes partially the rest of the processus Folianus, the anterior part of the axial ligament and the anterior pouch. The artery of the manubrium, arising from the union of these two tympanic branches just described, nourishes the middle portion of the mucous surface of the membrana tympani and the periosteum of the manubrium, excepting that of the lateral part; on the other hand, the inferior segment of the mucous surface of the membrana tympani is nourished by a small twig coming from the floor of the tympanum, and striking upon the mucous surface at about the middle third of the inferior periphery of the annulus, and at the spot mentioned dividing into two minute twigs, a thicker one, passing backward and upward, and a thinner one,

passing forward and upward; the terminal branchlets of both of these uniting with those of the main artery of the manubrium, at its crossing over from the middle of the inferior portion of the mucous surface.

The separate branches of the artery of the manubrium, bound with one another by transverse anastomosing branches, pass radiatingly across the mucous surface quite to the periphery. These anastomoses have, close to the manubrium, a slightly bow-shaped form. The capillary loops, present at periphery, do not belong to the circulation just described, but originate from the tympanic capillaries, whose terminal loops pass a trifle beyond the region of the annulus, and over upon the membrana tympani (Prussak, Kessel). The closely arranged capillary network of the mucous surface is made up of the vessels arranged radiatingly.

The relation of the artery of the mucous surface, in many animals, deserves especial observation. Dr. C. H. Burnett, of Philadelphia, described in a previous communication* the constant appearance of looped vessels on the mucous surface of the membrana tympani of dogs, cats, and rabbits. His preparations were treated partly with gold chloride and partly with osmic acid. I can confirm his results from injected preparations from dogs and rabbits (compare fig. 11); that is to say, vessels pass off in various directions from a plexus of vessels on the manubrium, and after a short course bend around in *loop-like* way, so as to return to the plexus of the manubrium. We see *loop-like vessels* of quite analogous arrangement, running from the whole periphery of the membrane radiatingly and centripetally towards the manubrium. The capillary network situated between the manubrium and periphery, which is but slightly different in its arrangement from the capillary network of the human membrana tympani, is formed of vessels, some of which run downward, others transversely.

The *veins* of the mucous surface of the membrana tympani develop from their capillary network, in a manner similar

* Monatschrift für Ohrenheilkunde, 1872, No. 2.

to that of the arteries. They pass radiatingly from the periphery towards the manubrium, and *vice versa.* In the intermediate zone they unite freely with one another by neighboring branches, most of which run obliquely. At the border of the membrana tympani they open into a large wreath of venous vessels, in whose formation we find as sharers venous branches of the mucous surface of the tympanum, of the periosteum of the annulus, of the bordering parts of the periosteum, of the wall of the tympanum, and at the superior segment of the membrane, even some venous branches of the pouches of the tympanum. This plexus at the border of the whole circumference of the membrana tympani (fig. 6) communicates with the corresponding wreath of veins in the cutis-layer by means of perforating branchlets ; furthermore, as mentioned already before (fig. 1), perforating veins run from the mucous surface in an oblique direction to the intermediate part of the network of veins of the cutis-layer. Those of the veins of the mucous surface which betake themselves to the manubrium run upwards alongside of it, in a netlike arrangement. During this upward course, venous blood is received also from the periosteal veins of the manubrium, in so far as it does not flow off laterally (compare above), finally also from that segment of the pouches of the tympanum situated nearest the manubrium. The blood streaming backward from out these venous districts collects at last in several larger venous stems which run along beneath the posterior pouch, into the neighborhood of the neck of the malleus (Rüdinger), perforate Shrapnell's membrane, and after receiving previously the veins coming from the sulcus tympanicus, they unite with the veins of the posterior wall of the external auditory meatus.

It follows from this account *that the blood can flow from the tympanum to the external auditory meatus* in three ways:

1st. Along the whole periphery of the annulus.

2d. Along the manubrium mallei through Shrapnell's membrane.

3d. By means of perforating veins in the intermediate zone of the membrana tympani.

GENERAL RESULTS.

From the description given, we learn that the membrana tympani forms a vascular district, the anatomical peculiarities of which are both physiologically and pathologically important to the membrane itself and the adjoining tympanic cavity.

The numerous capillary anastomoses overcome circulatory disturbances by a rapid and varied regulation, and the peculiar distribution of the venous channels in the several layers of the membrana tympani aids materially in the equalization of such disturbances.

In the membrana propria the blood flows without hindrance, and from the narrow, venous capillaries of the periosteum it empties into the spacious venous channels of the circular layer. It is true that the latter become somewhat narrow in their course toward the cutaneous veins, and thus offer a resistance that may cause a slackening of the current. But as at the same time the blood flows in a longitudinal direction, and empties into wide veins, a diminution in the rapidity of the flow does not take place in reality.

In the inner and outer networks of veins the flow of blood is greatly promoted by numerous anastomoses.

Several of the enumerated conditions likewise affect the circulation of blood within the tympanic cavity, which, as we have seen, sends its blood through the membrana tympani by three ways, and partly through venous channels in direct communication with those of the membrana tympani.

Thus a hyperæmia of the membrana tympani cannot readily occur, either in the normal condition or even in temporary disturbances of circulation, while, on the other hand, the cavity of the tympanum will retain its necessary amount of air. Prussak, in speaking of the vascular system of the promontory, where he finds long, thin arteries divided into branches, the calibre of which may be styled large in comparison with the size of the main trunks, demonstrates that the blood here circulates under low pressure and great rapidity, circumstances unfavorable to the occurrence of exudation.

The numerous capillary anastomoses would, no doubt, form an essential factor in the equalization of circulatory disturbances, consequent upon embolism in the membrana tympani. Thus far, only two observations of embolic processes within the auditory apparatus have been recorded. Fourteen years ago, Friedrich communicated a case to me, where, in the course of an endocarditis, sudden total deafness had occurred, as the cause of which, upon autopsy, an embolism of the arteria interna auditiva was found, and ten years later, Wendt described (Archiv für Heilkunde, 1873) an embolic process in the mucous membrane of the tympanic cavity.

This constitutes all our knowledge of embolic processes in the auditory apparatus. It may not prove a thankless task to study the intra-vitam and post-mortem appearances of the membrana tympani in cases where embolic processes have been diagnosticated in other parts of the body.

HEIDELBERG, October 17, 1877.

EXPLANATION OF THE PLATES.

Translated by EDWARD FRIDENBERG, M.D.

FIG. 1. Transverse section through the end of the manubrium and the adjoining portion of the drumhead; child stillborn four weeks before term; not injected; Hartnack II. 2; enlarged 27 diam. In the centre of the transverse section we see the substance of the manubrium, H G, imperfectly ossified, and in connection, at its edges as well as in its median portion, with the periosteum, respectively perichondrium, which is covered by mucous membrane, and runs laterally into the membrana propria (*m p*) of the drumhead. On the tympanic membrane we notice several longitudinal vessels cut transversely, and a similar section of a large transverse vessel; these are veins in the substantia propria. The large transverse vein with an apparently cæcal commencement, fig. 8, shows the origin of its roots in the region of the manubrial periosteum; perforates the membrana propria, its calibre diminishing slightly before it empties into the network of cuticular veins (*c v*). The veins to the right in the cutis receive a small vein *p*, perforating obliquely, from the mucous membrane of the drum-

head. s = mucous membrane ; c e = cuticular and epidermal layers.

FIG. 2. Transverse section through the manubrium at the junction of the lower to the middle third of the drumhead, and the adjoining portion of the external auditory canal ; mature stillborn child, injected through the abdominal aorta ; Hartnack II. 2 ; Scale $\frac{15}{1}$; p c = peripheral cartilaginous layer of the imperfectly ossified manubrium ; s g = section of submucous vessels surrounding the manubrium ; s = mucous membrane ; m p = membrana propria ; C and e = layers of cutis and epidermis. The imperfectly ossified manubrium is seen in transverse section with its periosteum, respectively perichondrium, in intimate connection at all points with the surrounding membrana propria. At a p between periosteum and membrana propria we see a periosteal artery commencing apparently as a cul-de-sac, and circulating around a portion of the manubrium. The radiating vessels of the membrana tympani appear in section as diaphanous spaces. Their calibre, greatest opposite the manubrium, diminishes gradually toward the periphery on the left side. At h a behind the manubrium the section of the primitive trunk of the manubrial artery. Externally to the left, the papillæ of the external auditory canal reaching almost but not quite to the drumhead. Several subcutaneous vessels are seen in section. Externally toward the left, the section of the bony wall of the external auditory canal.

FIG. 3. Transverse section of the manubrium near the middle of its lower third (right side), and of the adjoining portion of the drumhead from a child ten days of age, not injected ; Hartnack II. ; Scale $\frac{41}{1}$. The handle of the malleus is not yet perfectly ossified ; its perichondrium is closely united to the membrana propria at every point. The vessels of the adjoining cutis are seen in transverse section with the manubrial artery running *posterior* to the manubrium. In the submucosa of the edge of the manubrium, cut lumina of transverse and longitudinal vessels. H G = manubrium ; C = its peripheral layer of cartilage ; P = its perichondrium directly continuous with the membrana propria ; S = mucous membrana ; m p = membrana propria ; C and e = layers of cutis and epidermis.

FIG. 4. Transverse section through the middle third of the right manubrium and adjoining drumhead from a new-born child, injected through the carotid : Hartnack II. 4 ; Tube o, $\frac{41}{1}$; s = mucous membrane ; m p = membrana propria ; c and e = layers of cutis and

epidermis. The imperfectly ossified manubrium, H G, is seen in transverse section, with its periosteum covered by the submucosa and mucosa, and directly continuous at the lateral part of the manubrium with the membrana propria from the right side, while on the left side the membrana propria is perforated by a vessel belonging to the cuticular arterial system. This vessel is internal to the membrana propria, *i. e.*, in the tympanic cavity. Somewhat diminished in size, it partly surrounds the edge of the manubrium lying in the angle remaining between the membrana propria and the mucosa, and filled by the submucosa. Several sections of transverse and longitudinal vessels are seen in the submucosa. The artery running toward the periosteum of the manubrium (see above) is crossed near its bifurcation in the cutis by a smaller artery radiating toward the left. Just to the right of the point of crossing the transversely cut manubrial artery appears. In the cuticular layer of the membrana tympani, on the right side, there are sections of veins and capillaries. With the exception of the artery perforating it, the membrana propria is devoid of vessels as well as of capillaries.

FIG. 5. Longitudinal section through a portion of the annulus osseus and tendineus, and adjoining membrana tympani from a newly born infant. Not injected. Hartnack II. 4. $\frac{45}{1}$. *a o* = annulus osseus, its innermost portion in close connection with *a t* = annulus tendineus. *p* = section of blood-vessels of the annulus tendineus. Internal to these, along the entire edge, sections of vessels which run in different directions, with larger and smaller apertures close to the inner edge of the annulus tendineus. The vessels which connect the venous plexus on the tympanic side of the annulus with similar plexuses in the cuticular layer near the edge of the drumhead, pass through these apertures, cf. next figure.

FIG. 6. Transverse section through the annulus tympanicus osseus, the adjoining portion of the tympanic cavity, the annulus tendineus, the neighboring cutaneous investment of the external auditory canal, the drumhead, the manubrium, and the posterior tympanic pocket from a child stillborn four weeks before term. Left temporal bone, not injected. Hartnack II. 2, $\frac{45}{1}$. The cut lumina of longitudinal vessels are seen in the submucosa of the manubrium, the membrana tympani, and tympanic pocket, more numerous, however, in the cutis of the drumhead. The lumina opposite the manubrium and in its immediate vicinity belong to longitudinal vessels (on the

right side of the drawing), those most external near the posterior edge of the drumhead belong to transverse veins, the direction of which is partly centripetal, partly centrifugal (toward the external meatus). At one point they communicate, through a perforating vein, with a plexus made up of branches originating in the mucous membrane of the drumhead and of the tympanic cavity, in the tympanic pocket, and in the periosteum of the annulus and of the adjoining portion of the tympanic cavity. At *a* an artery running posterior to the manubrium, H G = Manubrium, T *r* = Drumhead, T *a* = posterior ligament of the pocket, *r a o* = region of the bony ring, *r o p* = region of adjoining bony wall of the tympanic cavity.

FIG. 7. Longitudinal section (not injected) through the following parts: inner end of the upper wall of the bony auditory canal with its dermal covering, and the commencement of the lateral end of the tegmen tympani, membrana flaccida, processus folianus, neck of malleus, processus brevis, manubrium, and all layers of the membrana tympani unto the end of the manubrium. The section is not exactly perpendicular; *k w* = inner end of the upper wall of the external bony canal; *m s* = region of middle cerebral fossa; *s s* = lateral end of the tegmen tympani; *m f* = membrana flaccida Shrapnelli; *p f* = processus folianus; *p b* = processus brevis; *h h* = neck of malleus; *g a* = commencement of manubrium; *g e* = broad end of manubrium; *c e* = cuticular and epidermal layers of drumhead; *m p*=its membrana propria; *k g* = bony manubrium; *s l* = layer of mucous membrane. At the lower third of the manubrium we see cuticular venous vessels, for the most part longitudinal in direction, communicating near the junction of the lower to the middle third of the manubrium with venous vessels of the central layers. The latter diminish in size horizontally, while they increase upwards towards the processus brevis. The horizontal veins are spiral, the others running upwards are straighter. They perforate the substantia propria removing the venous blood from the periosteum of the manubrium. With the low power used, their origin seems to be cæcal. With a higher power we get the following picture.

FIG. 8. A segment of another longitudinal cut of the preceding preparation enlarged 115 diameters Hartnack II. 5, tube drawn out. *k* = bony manubrium with the mucous membrane (*s*); *p* = periosteum; *c* = circular layer; *r* = radiating layer of drumhead; *c* = layers of cutis and epidermis with cuticular vessels cut longitudinally. At the

upper part of the drawing we see several venous capillaries leaving the periosteum to enter the circular layer, ascending at first, then running transversely and anastomosing partly with venous vessels of the circular layers. The radiating layer in this section has no vessels.

FIG. 9. Drumhead of a child. Preparation of the surface, treated with osmic acid. $\frac{12}{1}$. The covering of the malleus has been removed according to the method detailed in the preface. To the right and the left (lower part of drawing), the torn edges of the covering of the manubrium. We see a small segment of the central portion of the drumhead, also the lateral periosteal surface of the manubrium facing the external auditory canal, with the venous vessels of the periosteal layer and their numerous anastomoses. The light lines represent the contours of the vessels, the black lines indicate their contents coagulated by the osmic acid.

FIG. 10. Portion of the drumhead of a rabbit injected with carmine glue. $\frac{17}{1}$. In making this preparation, the investment of the malleus was cut open through the mucous membrane, and the edges having been folded back, the manubrium was dissected out. Hence we see the lateral side of the manubrial investment from the inside, *i. e.*, from the side of the tympanic cavity, together with a portion of the adjoining mucous surface of the drumhead (lower segment). While being drawn, the preparation was placed on a hollow slide. The longitudinal stripes on the membrana propria correspond to the direction of the fibres of the membrana propria. The small cells are detached cells of the perichondrium, which have adhered to the membrana propria. To the right of the drawing, in the region of the edge of the manubrium, an ascending vessel from the arterial system of the mucous membrane which spreads out over the region of the manubrium after dividing in two. Before its bifurcation it anastomoses in its lower third by delicate twigs with the capillary network of the mucous membrane, which network is seen to spread out in the furrows of the epithelium. A somewhat larger arterial branch, lying at a greater distance from the edge of the manubrium, also sends fine ramifications to the periosteum and larger twigs in the opposite direction to anastomose by their capillary network with the capillaries of the mucous membrane. This preparation had lain in absolute alcohol, which was renewed from time to time, for a number of years.

FIG. 11. Preparation of the drumhead of a rabbit injected with Prussian blue through the common carotid. Scale $\frac{15}{1}$. For drawing,

the preparation was placed on a concave slide. The cuticular capillaries of the drumhead are viewed here from the side of the mucous membrane. They are of a blue color, the red vessels belonging to the mucous membrane of the drumhead. From a plexus at the posterior boundary of the manubrium, vessels diverge, and forming loops, return to the plexus. Vascular loops of analogous shape run from the entire periphery of the membrane in a radiating centripetal direction toward the manubrium. The arterial capillary network between the manubrium and the periphery is formed by ascending and transverse vessels. Several arterial twigs run from the arterial trunks on the mucous membrane toward the manubrium, their terminal ramifications crossing the twigs of the cuticular network.

FIG. 12. Preparation of the surface of the drumhead and the manubrium (right side) from a child of three months, injected through the common carotid with Prussian blue. Hartnack II. 2; Tube 0, $\frac{6}{1}$. The entire hammer and the drumhead are shown. The trunk of the manubrial artery was downward behind the processus brevis, making an acute angle with the commencement of the lower third of the manubrium. During its course the calibre diminishes gradually, and small radiating twigs are sent off on either side. Near the lower third of the manubrium it divides, like a fork, into two large branches, which unite again in an arc on its lateral surface. From this arc and from the branch of the fork radiating twigs are also given off to supply the lateral sectors of the drumhead with arterial blood. For drawing, this preparation, being in connection with the annulus osseus, was placed on a hollow slide.

HEARING TESTS AND POLITZER'S UNIFORM ACOUMETER.

By DR. ARTHUR HARTMANN, Berlin.

Translated by Dr. Clarence J. Blake, Boston.

As the determination of the degrees of perceptive power of the organs of special sense presents considerable difficulties, an exact determination of the perceptive power of the organ of hearing is by no means easy.

As the measurement of the sensibility of a nerve must be an impulse of determined intensity, we must employ for determination of the perceptive power of the auditory nerve tones of a given intensity. Careful experiments in this direction were made by Schafhäntl, who made use of a ball falling from a certain height as a sound source. Itard appears in the literature of this subject as the inventor of a pendulum acoumeter. Itard's instrument consists of a freely suspended copper ring, against which a pendulum with a metal ball strikes. The elevation of the pendulum can be measured on a graduated circle, and the intensity of the tone be thereby determined. A German named Wolke described an instrument constructed on precisely the same principle at an earlier date than Itard. Wolke employed as sound source an upright sounding board of fir wood, against which a mallet of oak wood was allowed to fall through a given space. The principle of this acoumeter was exactly that of Itard's, the only difference being that wood was employed instead of metal.*

Boerhave† saw in the lamina spiralis of the cochlea a delicate

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* Nachricht von den zu Jever durch die Galvani-Volta'sche Gehörgebekunst beglückten Taubstummen. Oldenburg, 1802.

† Institutiones medicæ, Lugd. Batav., 1727.

mechanism with a number of chords of uniform tension, which vibrated sympathetically to every tone—a theory recently and more precisely elaborated by Helmholtz.

As pathological conditions induce not only variations in the perceptive power of the nerve, but may also affect the chords mentioned by Boerhave, the terminal fibres of the perceptive apparatus in the labyrinth; and as also the transmitting power for tones of different quality may be affected in various ways, an exact determination of the perceptive power for tones of different pitch is necessary to the accurate measurement of hearing.

In addition to the numerous instruments constructed for exhibition of a particular tone since that of Wolke, various other instruments have been constructed to test the perception for tones of various pitch.

All the apparatus as yet constructed has the disadvantage of being too complicated and unpractical to come into general use.

Notwithstanding the demand for a sound source, the determinable intensity of tone which could be employed not only in scientific experiment, but also to serve a practical use in the determination of the degrees of deafness, experiments so far made in this direction have failed on account of the disadvantages above-mentioned of all the instruments as yet constructed; and we see therefore in general use as hearing-tests, the voice, the watch, and, particularly, for test of bone conduction, the tuning fork. Although these methods of examination have already been described in these ARCHIVES by Wolf,* I will mention them, as my views do not exactly agree with those of Wolf. When Wolf assumes that the human voice is approximately the most perfect test for hearing, because it is not readily supposable that an artificial mechanism can be constructed which shall reproduce the delicate shades in pitch, intensity, and quality of tone as this is done by the natural instrument of the human voice, and concludes therefrom that all attempts at

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* Bd. III., 2 Abth. Neue Untersuchungen, etc., von Dr. O. Wolf.

the construction of artificial acoumeters are and always will be futile, I cannot agree with him. As the oculist does not test vision by means of a complicated picture, including shades of color and various dimensions, the aurist cannot employ as a hearing test so complicated an acoustic picture as that presented by the voice.

Wolf himself has drawn attention, by his valuable investigations, to the great difference in perceptive power for different consonant sounds, and Pfingsten* has recommended the use of the alphabet as a hearing test, making three divisions, according to which the individual sounds were heard better or worse.

If, notwithstanding the fact that the voice is but poorly adapted to the measurement, we are still obliged to use it as a hearing-test, it is because we use our ears principally for the hearing of the voice, and this test, therefore, affords us a comparative measure of the diminished perception of speech, the restoration of which is of most importance to the patient. To obtain a more exact measure of the hearing power necessary to give greater certainty to our diagnosis and prognosis, we must employ definite tones, of a less complicated character.

In cases of a slight degree of deafness, test with the voice is in many of them of little value, as, with the relatively small space in which the examination is made, a whisper is often heard at the greatest distance at our command.

The disadvantages of the watch are, that it has two tones, that the intensity of these tones is very slight, and that the patient's estimate of the hearing is with difficulty controlled.

In testing with the watch at a short distance, the patient hears both ticks, while at a greater distance but one is heard, making it difficult to determine whether the ticking of the watch as such is heard or not.

In children and inattentive adults it is very difficult to obtain confirmatory results ; as a rule, patients consider their hearing to be better than it really is, and when the watch is not heard,

* Gehörmesser zur Untersuchung der Gehörfähigkeit galvanisirter Taubstummen in besonderer Rücks. auf d. Erlern. artik. Tonsprache und auf deren Elemente gegründet. 1804, Kiel.

an affirmative answer is not infrequent, the result being that the test is both unreliable and a loss of time.

The intensity of the tone of the watch being very slight, it must, with greater degrees of deafness, be pressed upon the ear, the conclusion in regard to the hearing power being thereby rendered more difficult on account of the conduction of sound through the bones of the head. In many cases, also, the intensity of the tone is too slight to serve as a test for bone conduction.

A further disadvantage in testing the hearing with the watch lies in the fact that the tick of different watches varies both in intensity and pitch; the comparison of different tests is therefore rendered futile.

The disadvantages of testing with the watch are indeed so many that Gottstein is justified in saying, "It is to be regretted that we have no better tests of hearing, and that we should be obliged especially to resort to test for perception of the voice." The disadvantages presented by tuning forks as exact tests for hearing are that the intensity of the tone is not determined, as we are not always able to strike a tuning fork with the same force; furthermore, the tuning forks used in examination usually vary so much both in pitch and intensity that it is difficult to compare observations coming from different sources. Politzer having undertaken the construction of an uniform acoumeter, such an instrument must possess, as will be seen from what is above said, the following qualities:

1. The construction must be more simple and the manipulation less complicated than in former acoumeters.

2. The intensity and pitch must be accurately determined, and the instrument must serve as a test as well for aerial as for bone conduction.

Politzer's acoumeter consists of a steel cylinder, four millimeters in diameter and twenty-eight millimeters long, set in vibration by the blow of a small hammer, also of steel.

The cylinder is fastened vertically to a small column of vulcanite, the hammer being freely suspended from a slot in this column by means of a pin. The lever of the hammer project-

ing behind and beyond, the vulcanite column can be depressed to a certain point, and when liberated, allows the hammer to strike the cylinder from a certain height, thereby insuring a certain intensity of tone. Two half rings being fastened at either end of the vulcanite column, the instrument may be held between the thumb and fore finger, the middle finger being free to set the hammer in motion. A small disk is also fastened to the vulcanite column by means of a pin, and is used for testing perception for bone conduction. The whole instrument is so compact that the case containing it may easily be carried in the vest pocket, and its construction is so simple that it can hardly get out of repair. The price, 5½ florins Austrian currency, is so small as to present no obstacle to the introduction of the instrument generally.*

All of the instruments are tuned to the tone C2 by careful filing of the cylinder.

The Politzer instrument has met in the first degree the demands previously given. Those who demand of an acoumeter that it should include a large number of tones will not be satisfied with Politzer's instrument. The loss or diminished perception for certain tones are discovered as a rule, not by our own examination, but by patients having a musical education. As this form of partial deafness is shown by observation to be an uncommon one, it would be hardly necessary to carry the usual examination in this direction, however desirable it may be to obtain exact information If it is so difficult and requires so much time to test the hearing for a single tone, whence can be had the time and the patience, in ordinary professional practice, to determine the perceptive power, of not one, but a whole class of tones?

The principal value of an acoumeter is to be found, not in the means of determining the perceptive power as a whole, but in detecting slight changes which may occur from time to time under varying circumstances, or as a result of treatment. The more exactly these changes can be determined, the greater will

* Optician Gottlieb, 12 Adlergasse, Vienna.

be their value in the diagnosis, prognosis, and the treatment of the case in hand. In the examinations which I have made, both in the subjects of normal and defective hearing, with this instrument, I deviated somewhat from the method given by Politzer.

According to Politzer, the determination of the hearing distance should be conducted like the test with the watch, the instrument approaching the ear until the patient announces that he begins to hear its tone. Under these circumstances, there is a certain space within which the patient is in doubt as to whether he hears or no; varying results being obtained.

The differences are partially explained by the psychical condition; the attention having been once attracted, the power of accommodation is exercised in a greater or less degree.

In order to determine definitely whether the patient hears the instrument or no, I require him to count the number of blows given by the hammer falling upon the cylinder; furthermore, I direct the attention of the patient to the sound before striking the cylinder; by these means a definiteness and certainty is obtained in testing the hearing not hitherto attained by other methods. For my examinations in cases of normal hearing, a considerable space, and, as near as possible, perfect quiet is necessary. I avail myself, therefore, of an empty ward of the Moabite Hospital, in which, far from the noise of the city, the experiments could be conducted undisturbed. I determined the hearing distance for my watch, for a whisper, and for Politzer's Acoumeter in twenty-five adults.

The determination of the average hearing distance of my watch showed it to be heard at a distance of 4½ paces = 3 metres.

The differences in individual cases were very marked, the ticking being heard in one case 2, and in another 12 paces. The results of the tests with a whisper were that it was heard almost without exception through the whole ward—36 paces =25 metres; while in a majority of cases certain of my test words were repeated, in some cases I was obliged to omit those which were most readily heard.

In but two cases was I obliged to shorten the distance in order to be distinctly heard, in one case by 3, and in another by 5 paces.

I believe, therefore, the distance of 25 metres to be determinable as the normal hearing distance for a whisper, with but slight outside noise.

With the louder noises, such as we usually have about our dwellings, this distance should be diminished by about 20 metres, the distance then very nearly corresponding to that given by Wolf (60′ Frankfurter Maass). In determining the average hearing distance by Politzer's Acoumeter, the extreme distances were 9 paces and 36 paces, and a diminished hearing for the Acoumeter corresponded to a diminished hearing for the watch, and in a less degree for the whisper; the average hearing distance was 23 paces or 15 metres.

Considering the hearing distance for the watch as 1, its relation to the acoumeter and whisper was as 1 : 5 : 8.

As has been already said, we require, in testing slight grades of deafness, a tone of less intensity than that afforded by a whisper, while, on the other hand, the watch, in many cases of high grades of deafness, gives too weak a tone.

As Politzer has given to his acoumeter an intensity which lies between that of a whisper and of a watch, his instrument is available as a test in the greater number of cases.

The above relations of the different methods of test to each other, as observed in persons of normal hearing, are found, as a rule, comparatively the same in different forms of deafness. If, in the determination of the hearing distance in a deaf person, there is an apparent mistake, I repeat the test, and not unfrequently discover, particularly in testing with the watch, that the patient had arrived at a false conclusion.

It is precisely in such cases that an opportunity is afforded for demonstrating the advantages of the Politzer instrument, especially when the patient is required to count the number of blows heard. In the former method of testing, bone conduction by the turning fork and watch, the relation of these sound-sources to each other and of speech could not be determined,

while in the Politzer Acoumeter we possess an instrument which affords us a sound source in the most complete sense for testing the aerial as well as bone conduction.

In order to show how desirable it is in many cases to have a sound source of greater intensity than the watch for testing bone conduction, I give the results of hearing tests of three children suffering from a high degree of deafness, resulting from naso-pharyngeal and tubal catarrh of several years' duration; the hearing distance given was before treatment.

	Aerial Conduction.						Bone Conduction from Mastoid.			
	Watch		Acoumeter.		Voice.		Watch.		Acoumeter.	
	l.	r.	l.	r.	l.	r.	l.	r.	l.	r.
K., 9 years old..	o	o	o	o	Loud: $1\frac{1}{4}$ m.	$1\frac{1}{2}$ m.	o	o	yes.	yes.
J., 13 years old..	o	o	4 cm.	3 cm.	Whisper: $1\frac{3}{4}$ m.	2 m.	o	o	yes.	yes.
F., 10 years old..	o	o	close to ear.	o	Loud: $2\frac{1}{4}$ m.	$1\frac{1}{2}$ m.	o	o	yes.	yes.

As in these cases, where there was no history pointing to a disease of the labyrinth, the watch was not heard by bone conduction, and the Politzer Acoumeter was so perceived, the latter instrument would be of greater value if the absence of perception by bone conduction is to be taken as an evidence of the probability of a disease of the labyrinth.

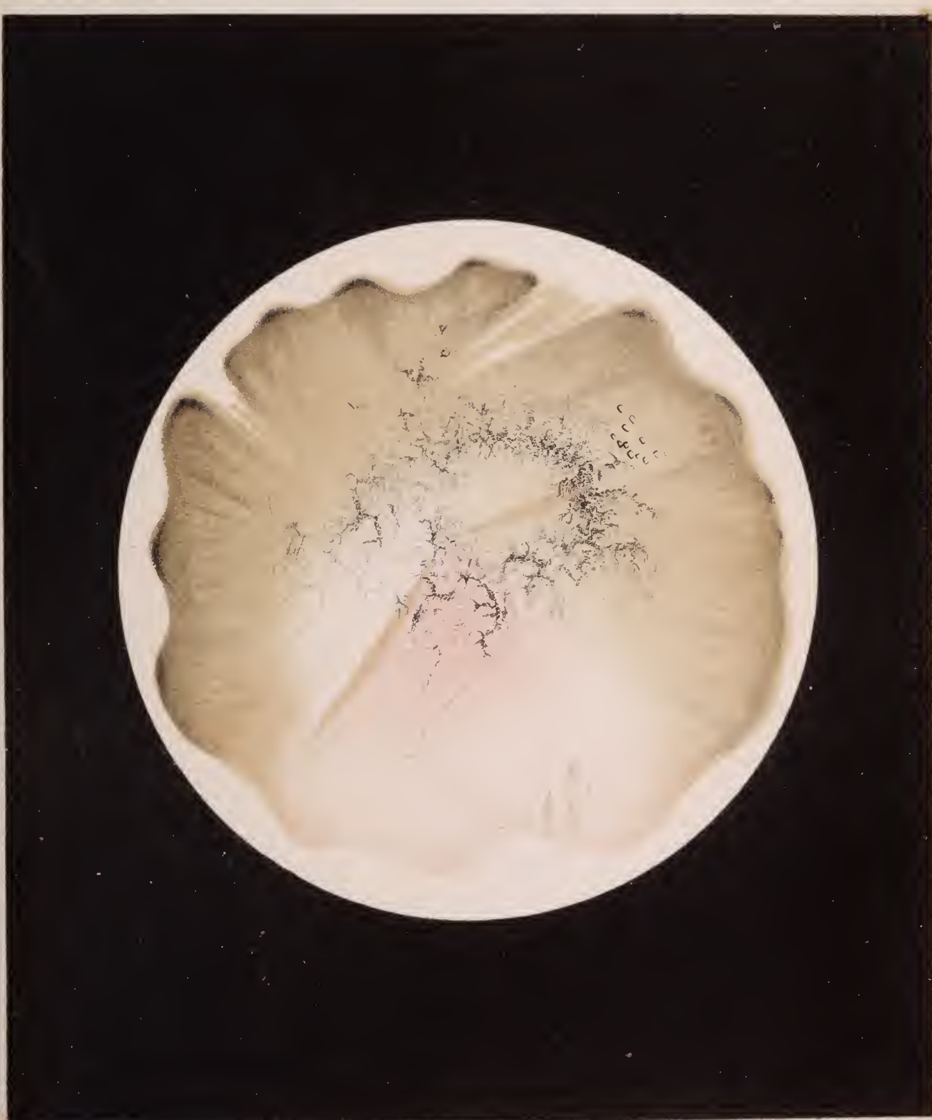
The advantages of Politzer's Acoumeter are, therefore, as follows:

1.—A sound source of constant intensity and pitch, both of which qualities have been chosen with reference to practical use.

2.—General applicability on account of simplicity, compactness, and moderate cost.

3.—Applicability to examination for aerial and bone conduction, it being better adapted to the latter purpose than the watch, on account of its greater intensity of tone.

As the results of my examinations, I consider the Politzer instrument as being in the highest degree qualified for general acceptance as a universal measure of hearing.



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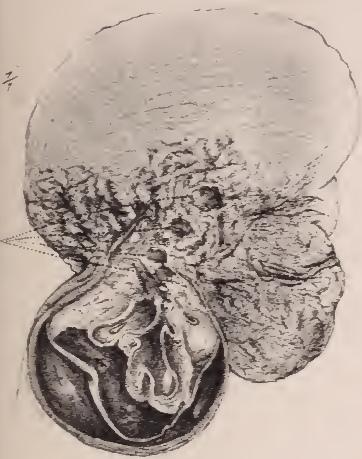

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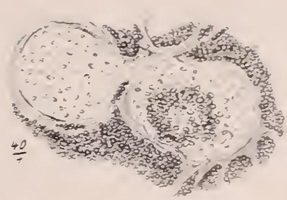

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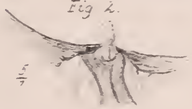

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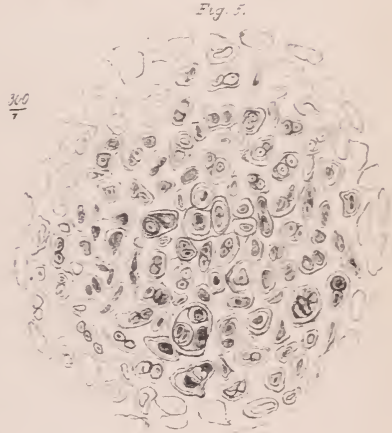

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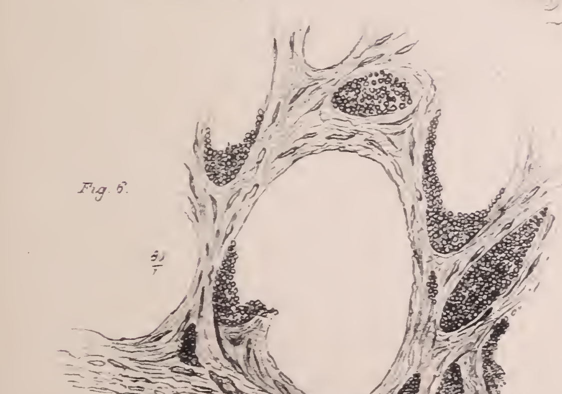

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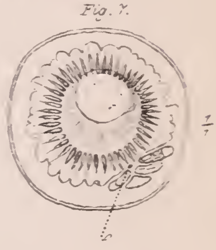

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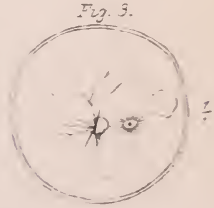

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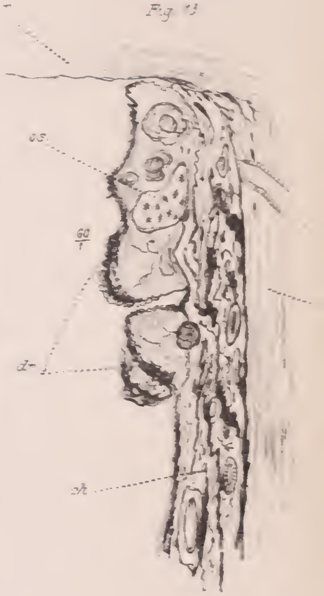
Fig. 9

Fig. 10.

Fig. 12.

Fig. 13



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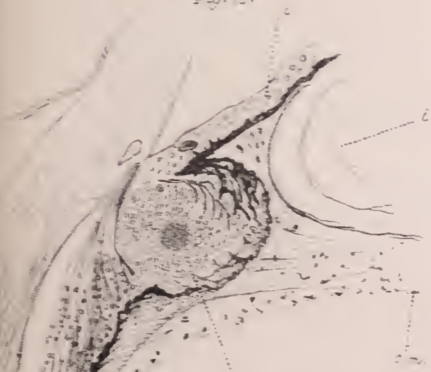

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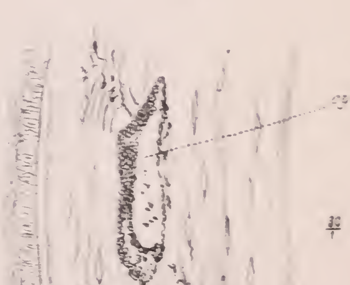

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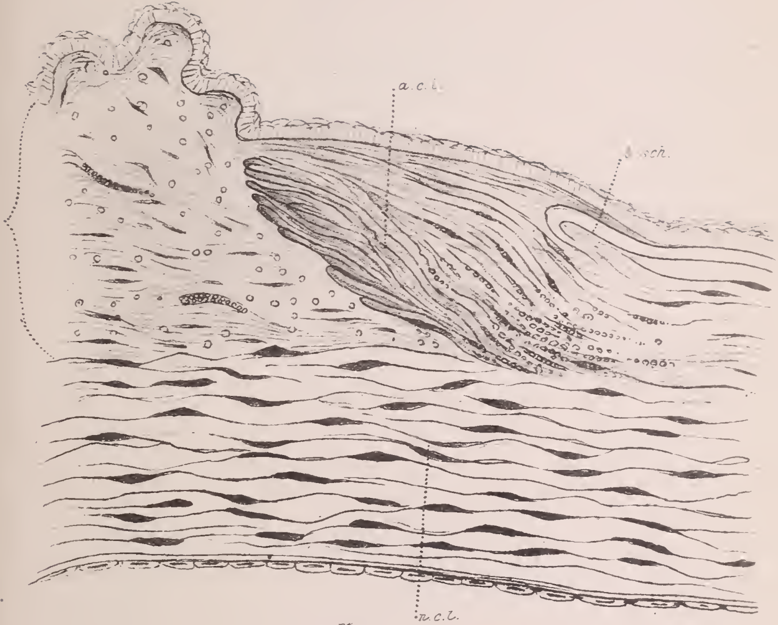

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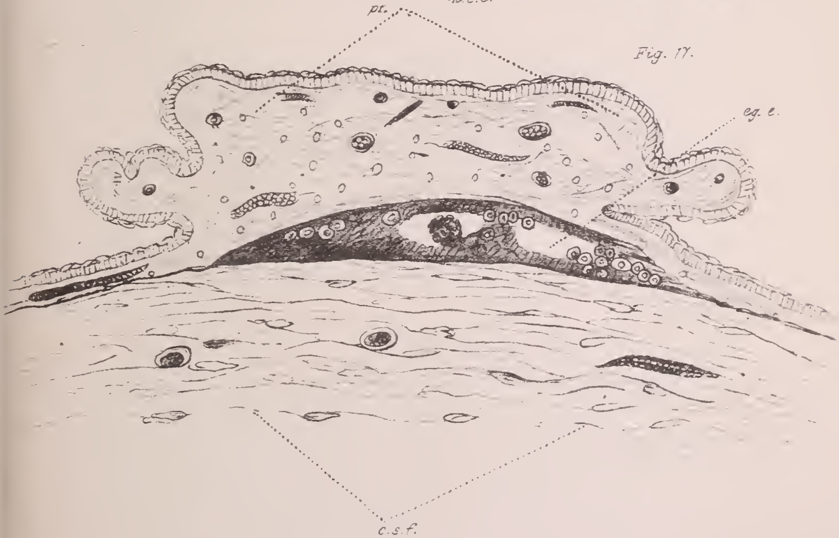

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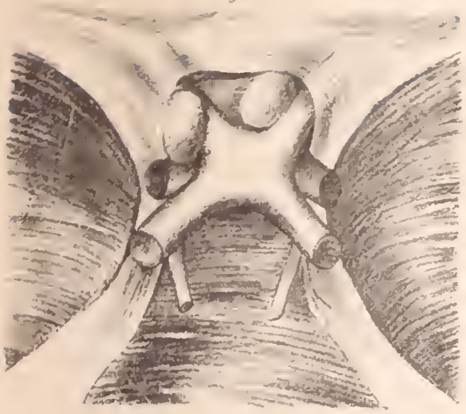

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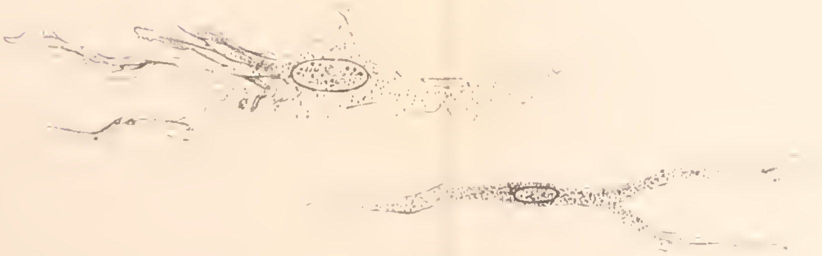

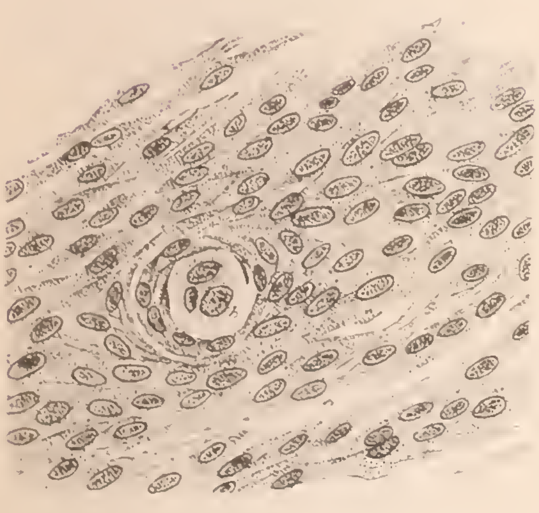

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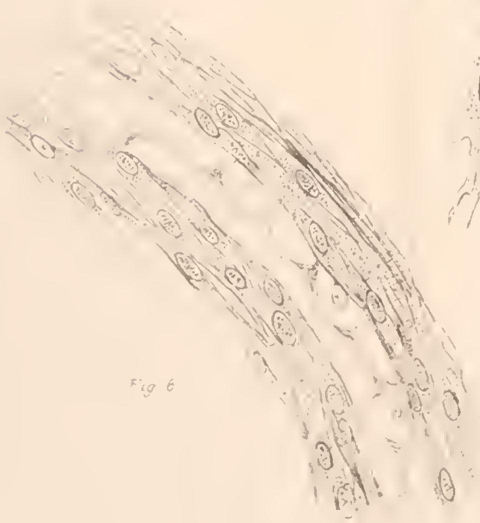

Fig 6

Fig 4.

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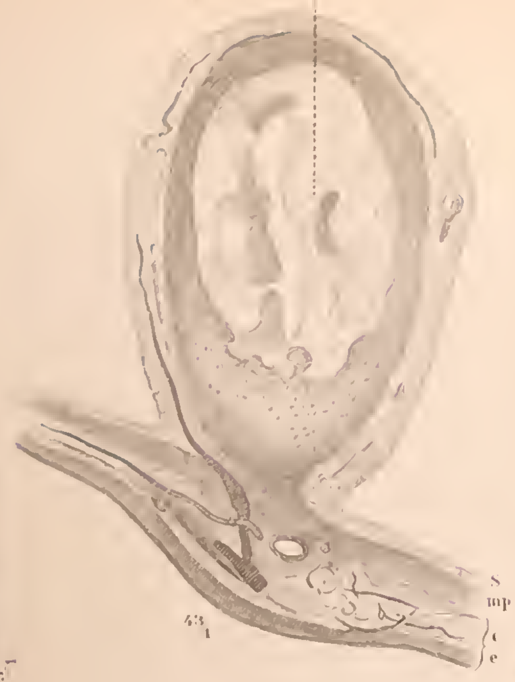
Fig. 4



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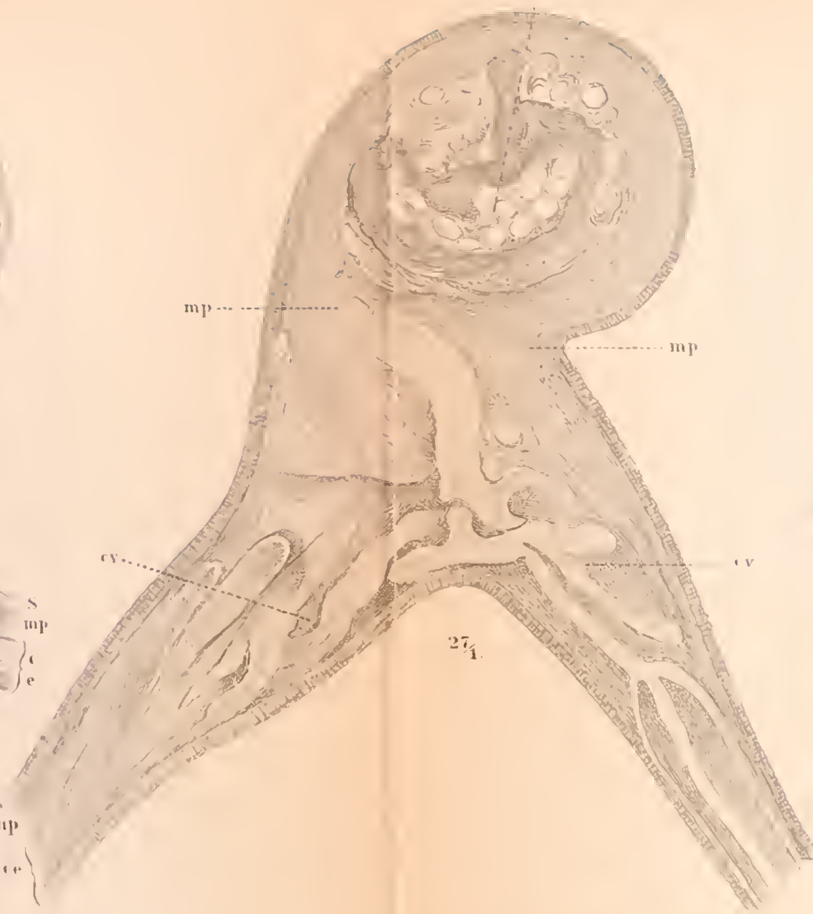

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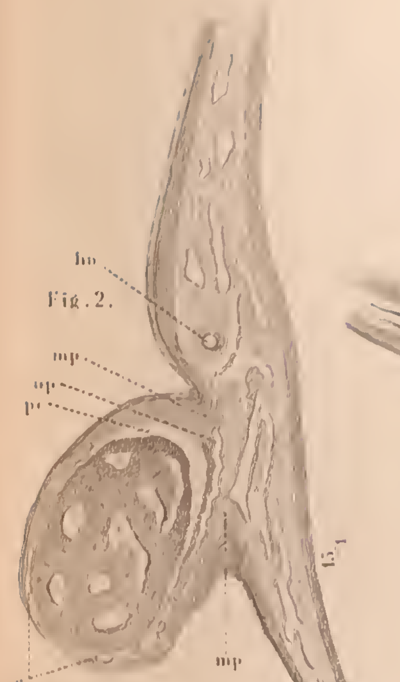

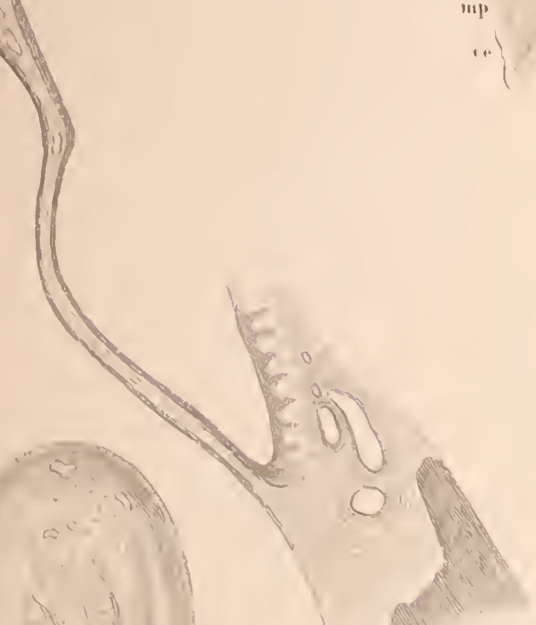

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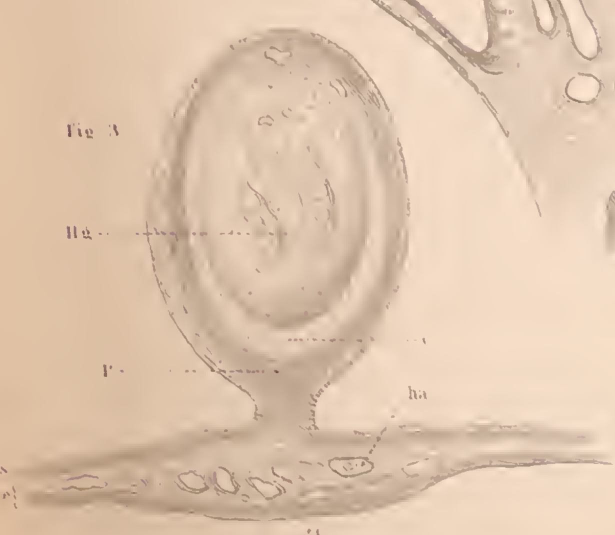

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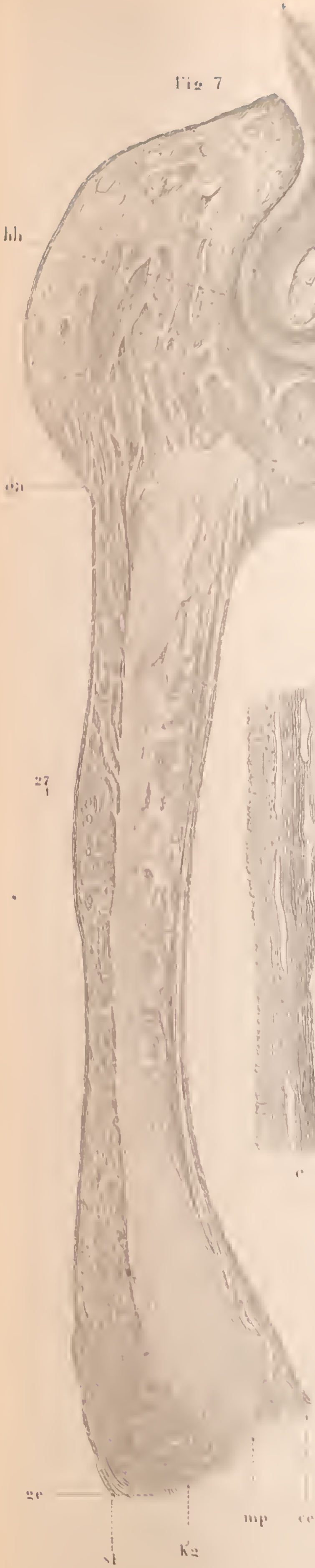

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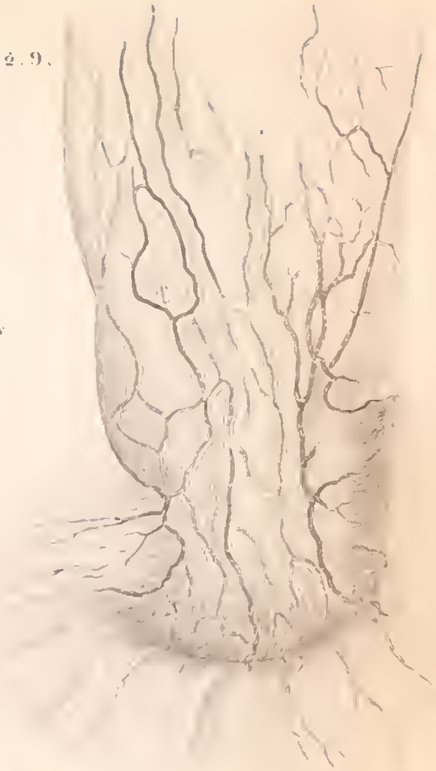

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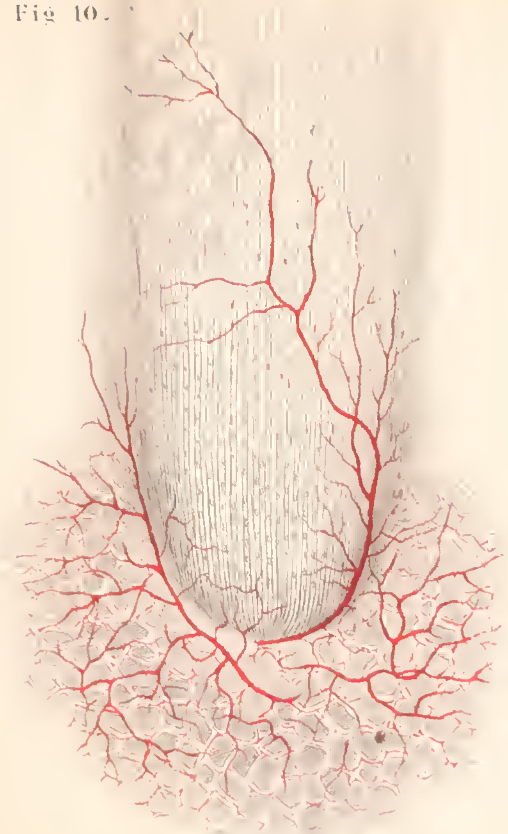

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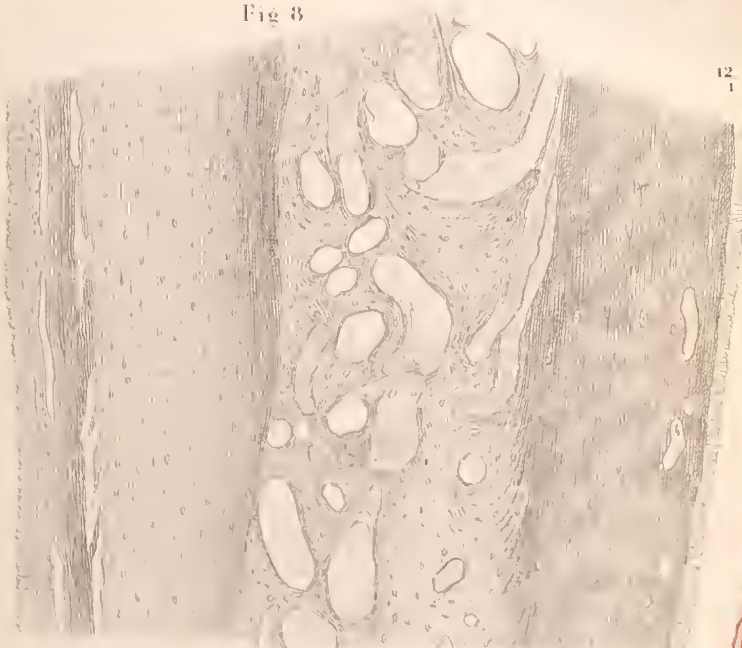

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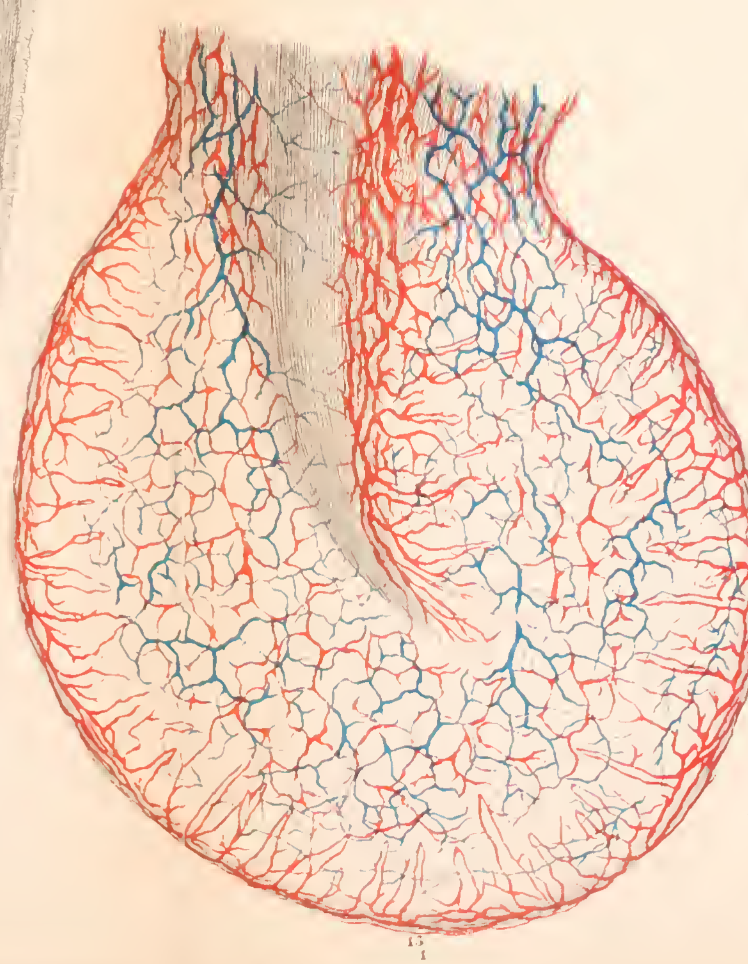

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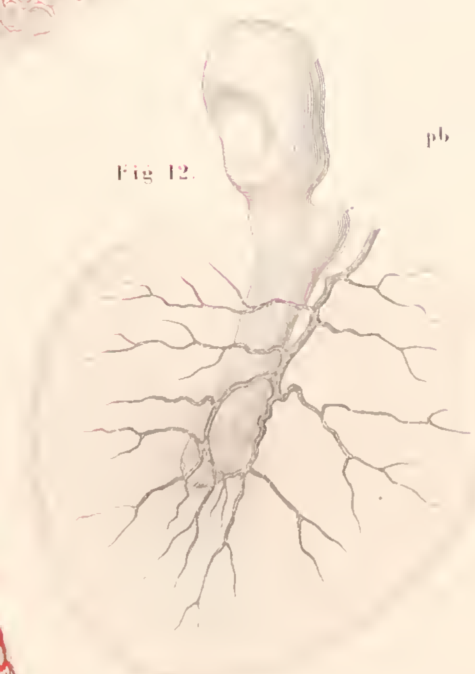

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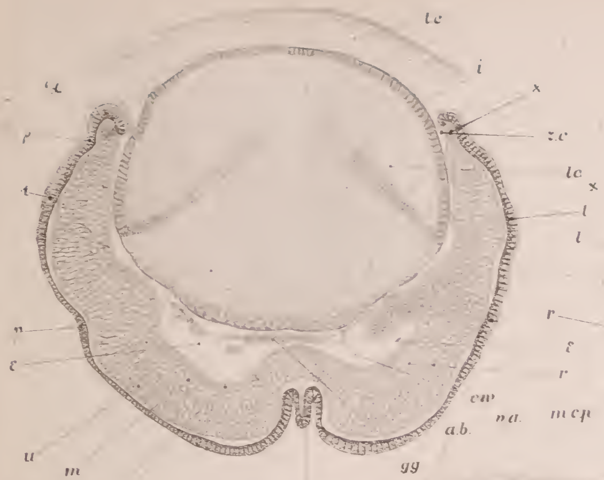

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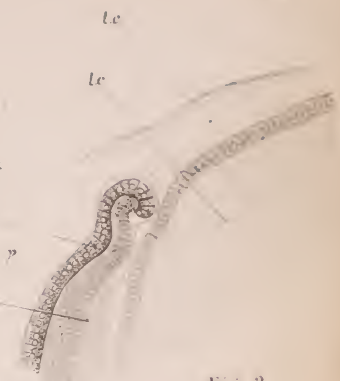

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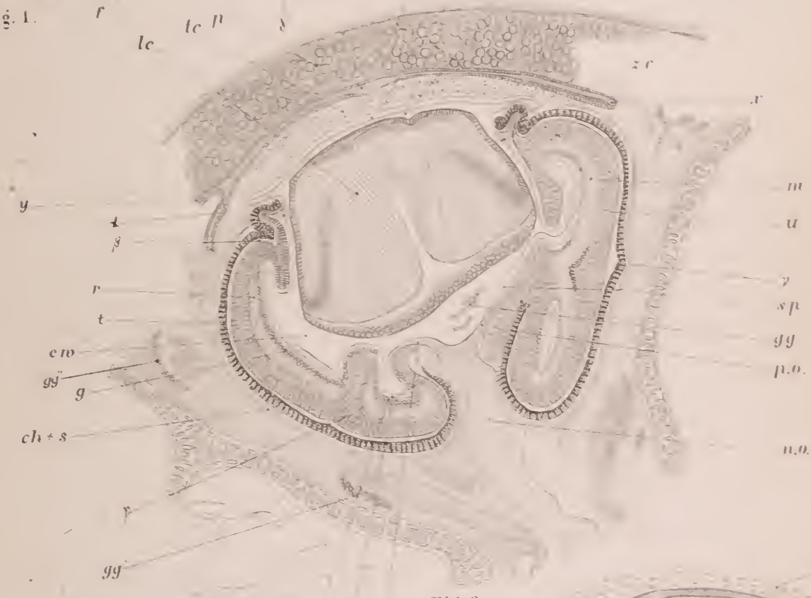

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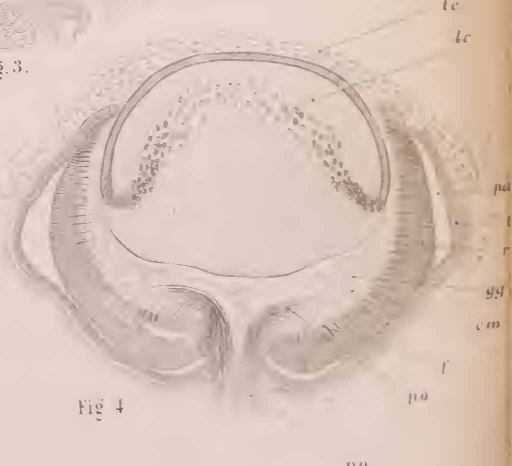

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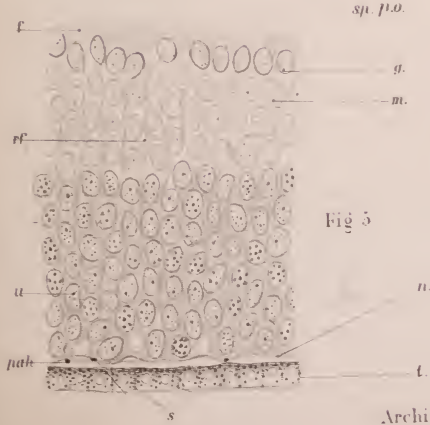

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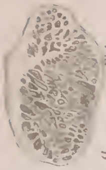

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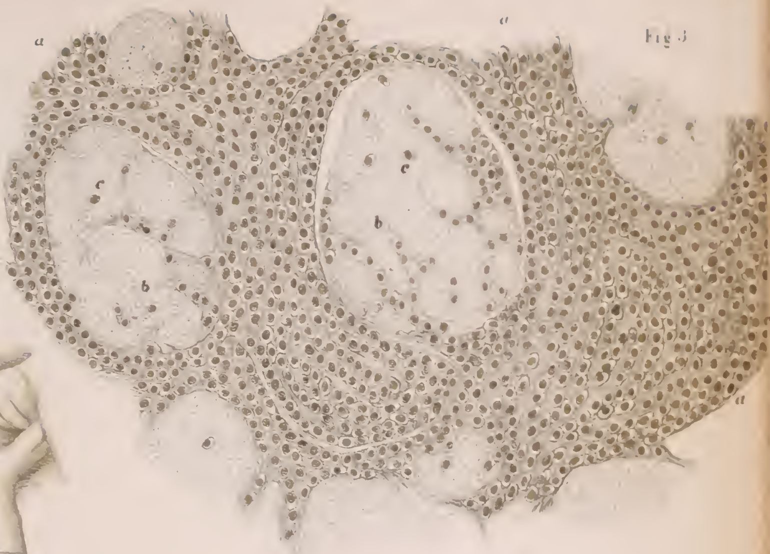

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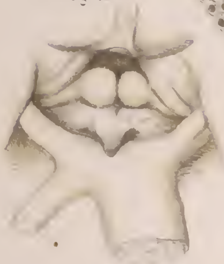

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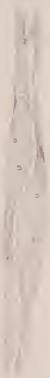

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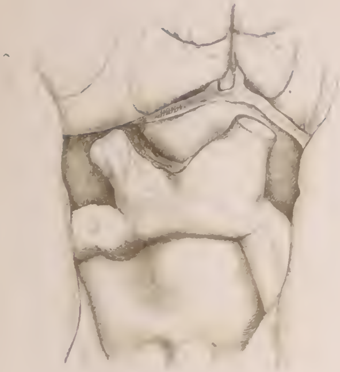

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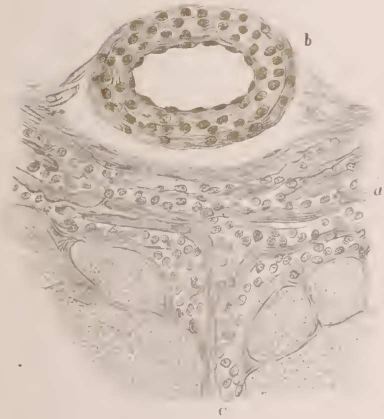

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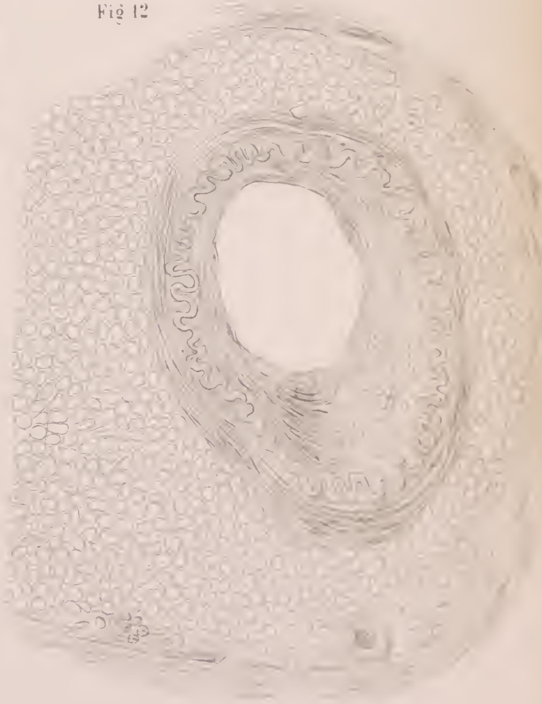

Fig 10